Overview of CSNE Carbon Analyses and Potential for Renewables

Cameron Wake, Matt Frades & George Hurtt
Institute for the Study of Earth, Oceans, and Space, UNH

Fourth Task Force Meeting
NH Audubon, Concord, NH
11 August 2008

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New Hampshire Climate Change Policy Task Force
Fourth Task Force Meeting

9:50 AM	Overview of CSNE Results and Potential for Renewables
10:20 AM	Economic Perspective
10:50 AM	BREAK
11:00 AM	Emissions and Economic Impact of Working Group Actions
	Electric Generation and Use (EGU)
	Residential, Commercial and Industrial (RCI)
1:00 PM	BREAK FOR LUNCH
1:30 PM	Emissions and Economic Impact of Working Group Actions (cont'd)
	Transportation and Land Use (TLU)
	Agriculture Forestry and Waste (AFW)
3:15 PM	Task Force Next Steps

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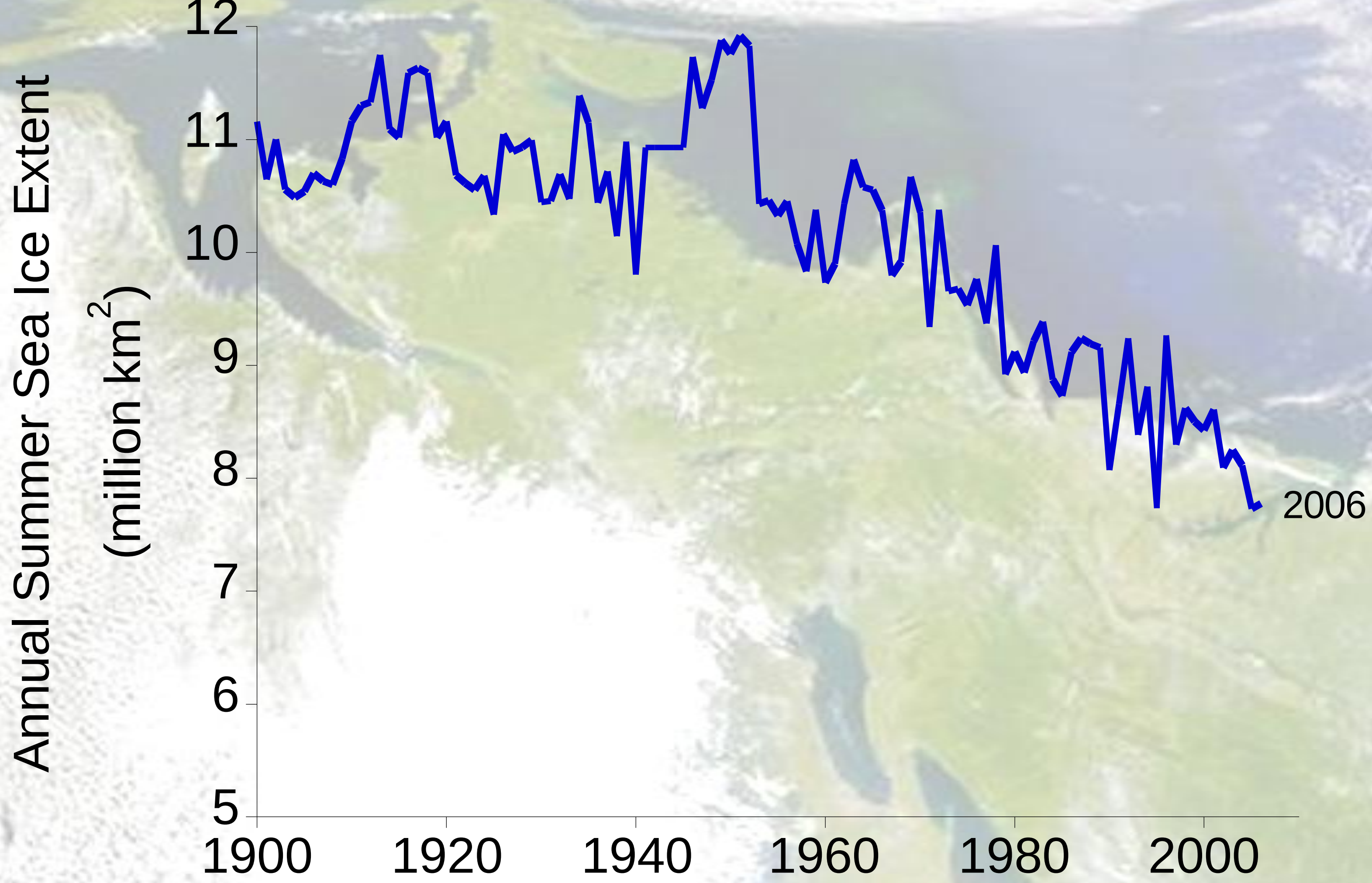
What is the Big Picture?

"Here's to missing the big picture."

Summer (JJA) Arctic Sea Ice Extent



University of Illinois - The Cryosphere Today http://arctic.atmos.uiuc.edu/cryosphere/

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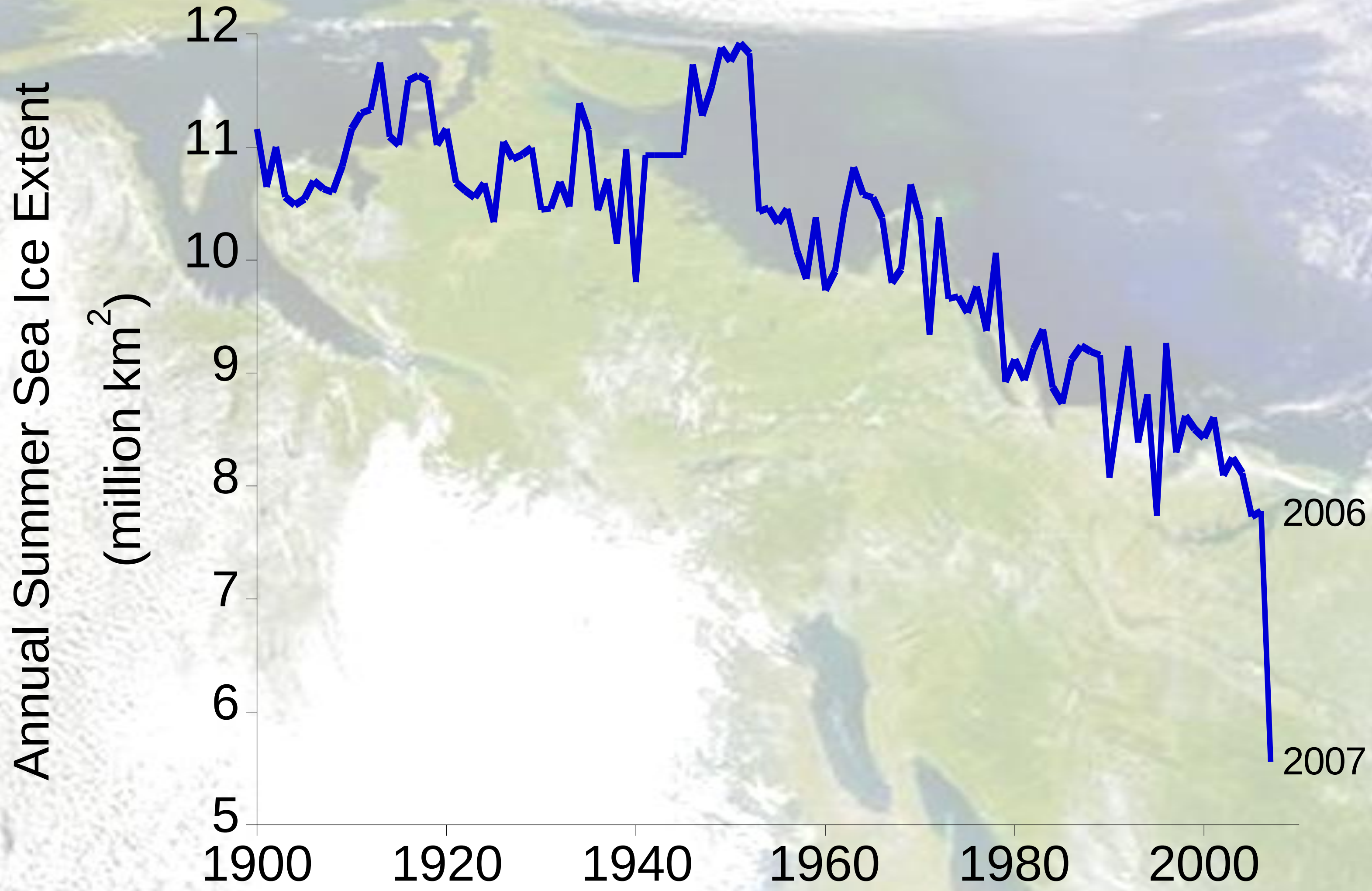

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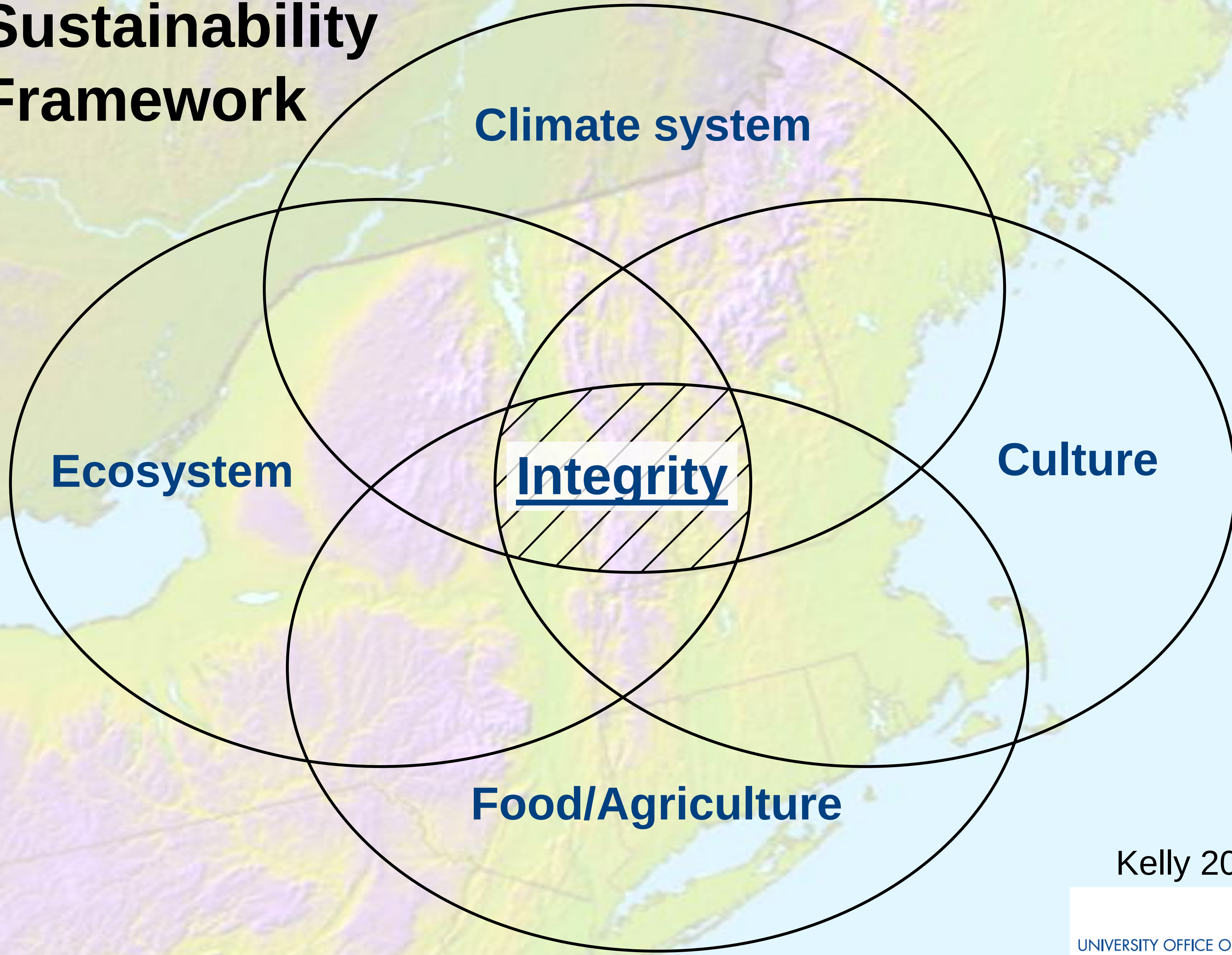
Sustainability Framework



Kelly 2006

UNIVERSITY OFFICE OF SUSTAINABILITY

Overview of CSNE Carbon Analyses

- Two handouts
  - -Analysis spreadsheet
  - -Approach and Assumptions document
- Analyzed actions for 4 Working Groups and quantified potential for CO_2 emission reduction and economic costs/benefits (can be refined!)
- CSNE analyses provide **ONE** set of decision relevant information; WG analysis sheets also provide valuable decision relevant info (e.g., implementation, related programs, other benefits/impacts, etc.)
- Developed examples of combined GHG reduction goals/actions for 4 Working Groups (RCI, TLU, EGU, AFW)
- Examples provide Big Picture by combining goals/actions that produce significant reduction in GHG emissions
- While this is state plan, need to consider regional & national perspectives in our discussions

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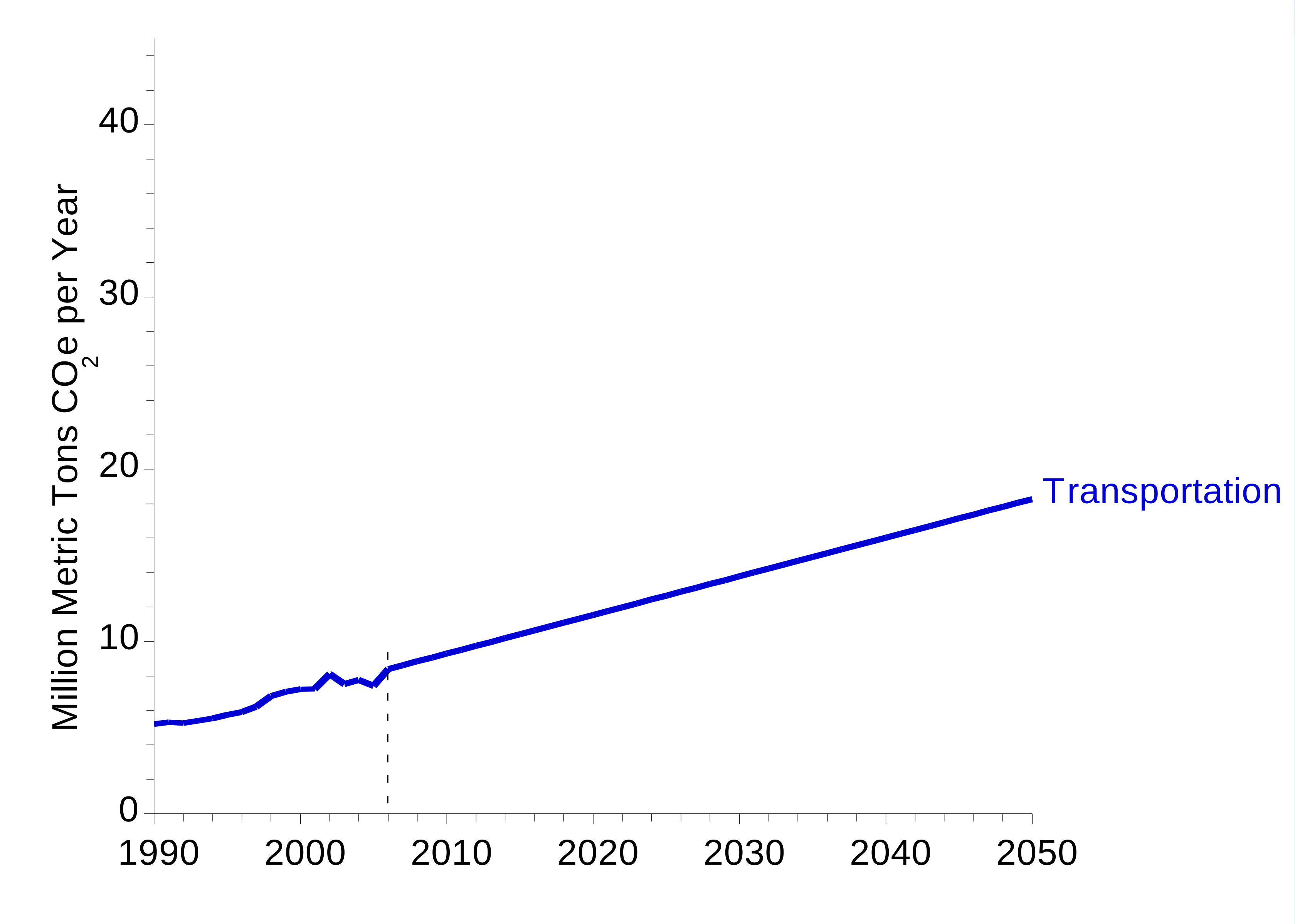
Annual Greenhouse Gas Emissions for New Hampshire



Historical data from EPA
Business as Usual (BAU) estimates from CSNE

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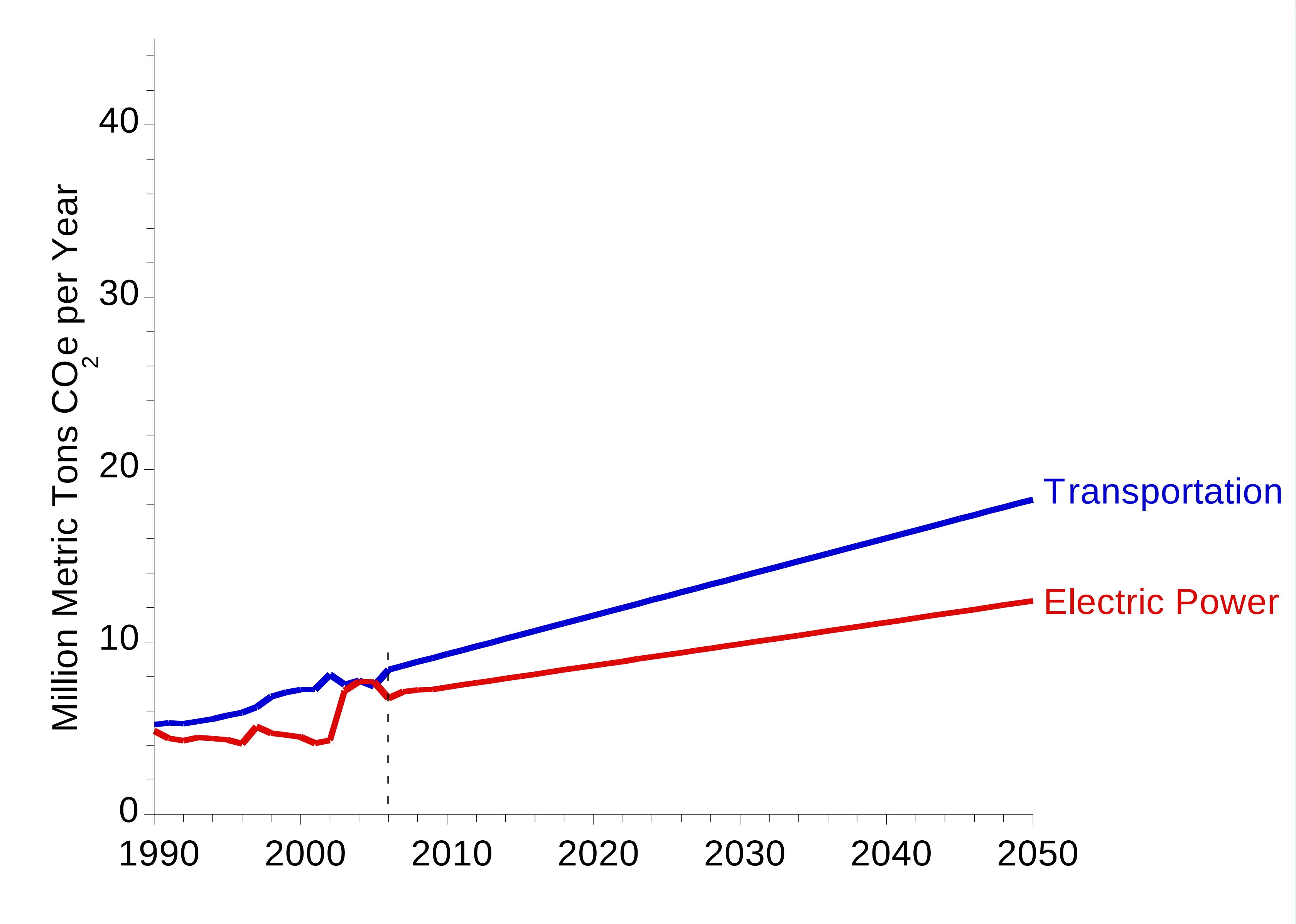

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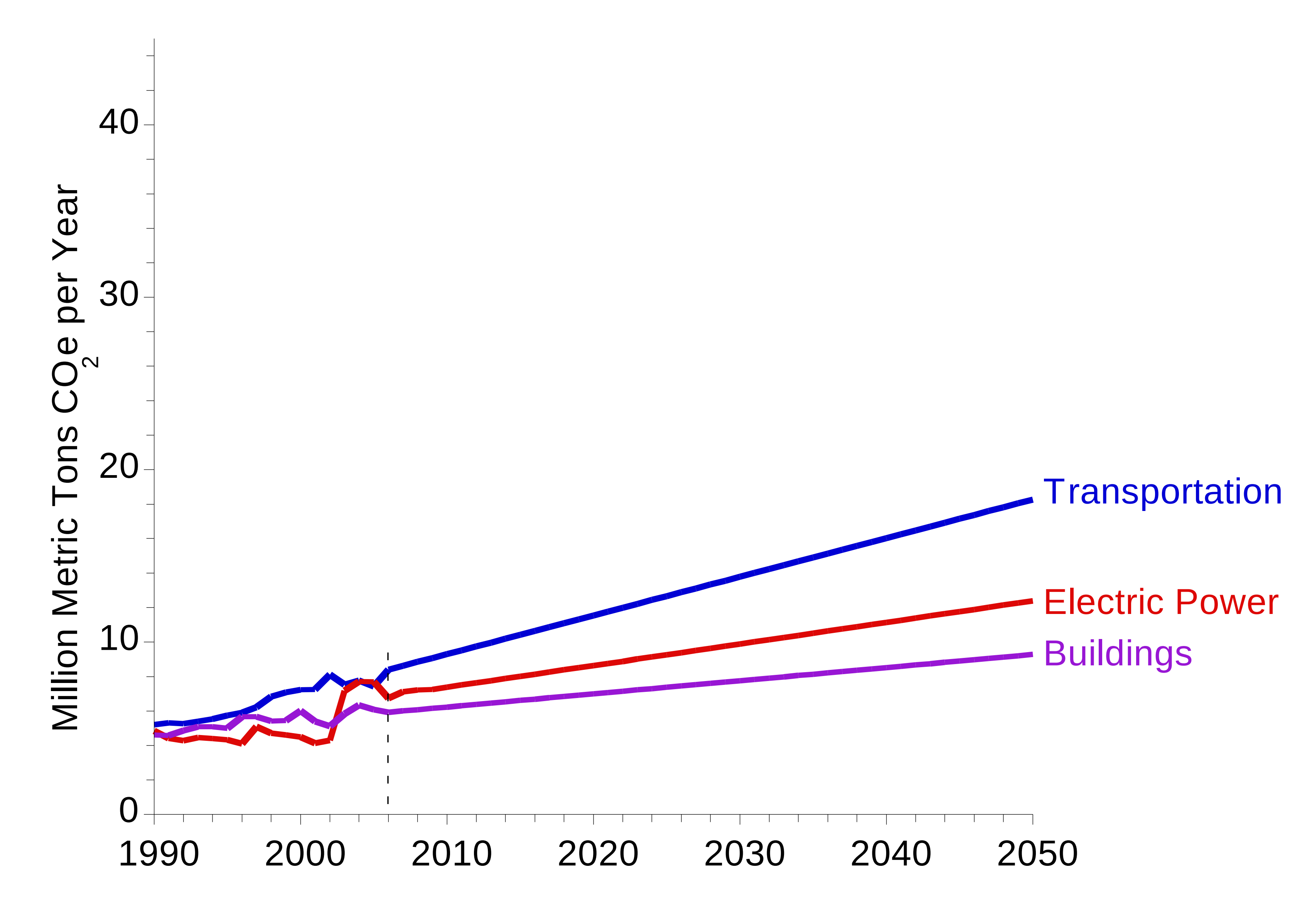

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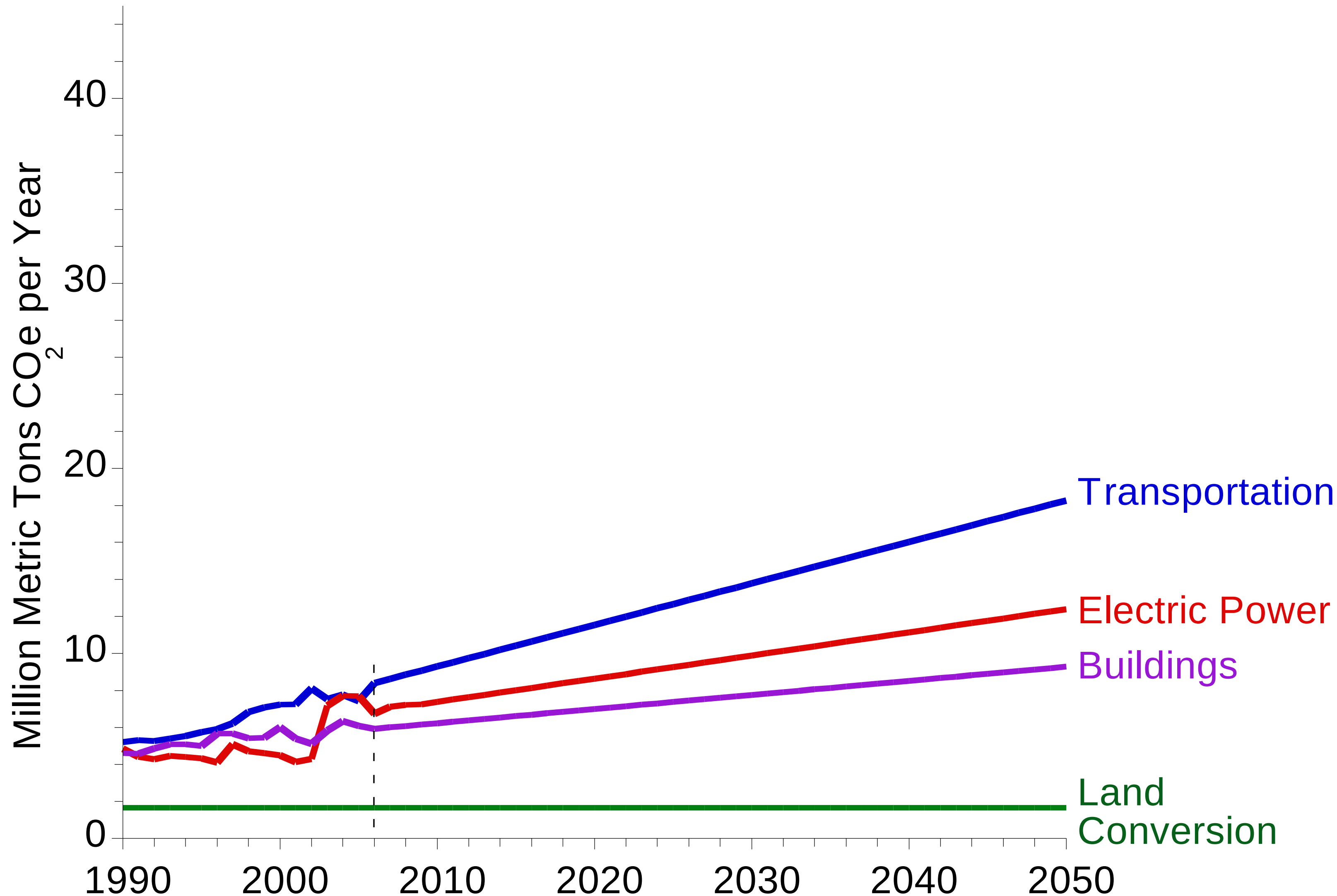
Annual Greenhouse Gas Emissions for New Hampshire



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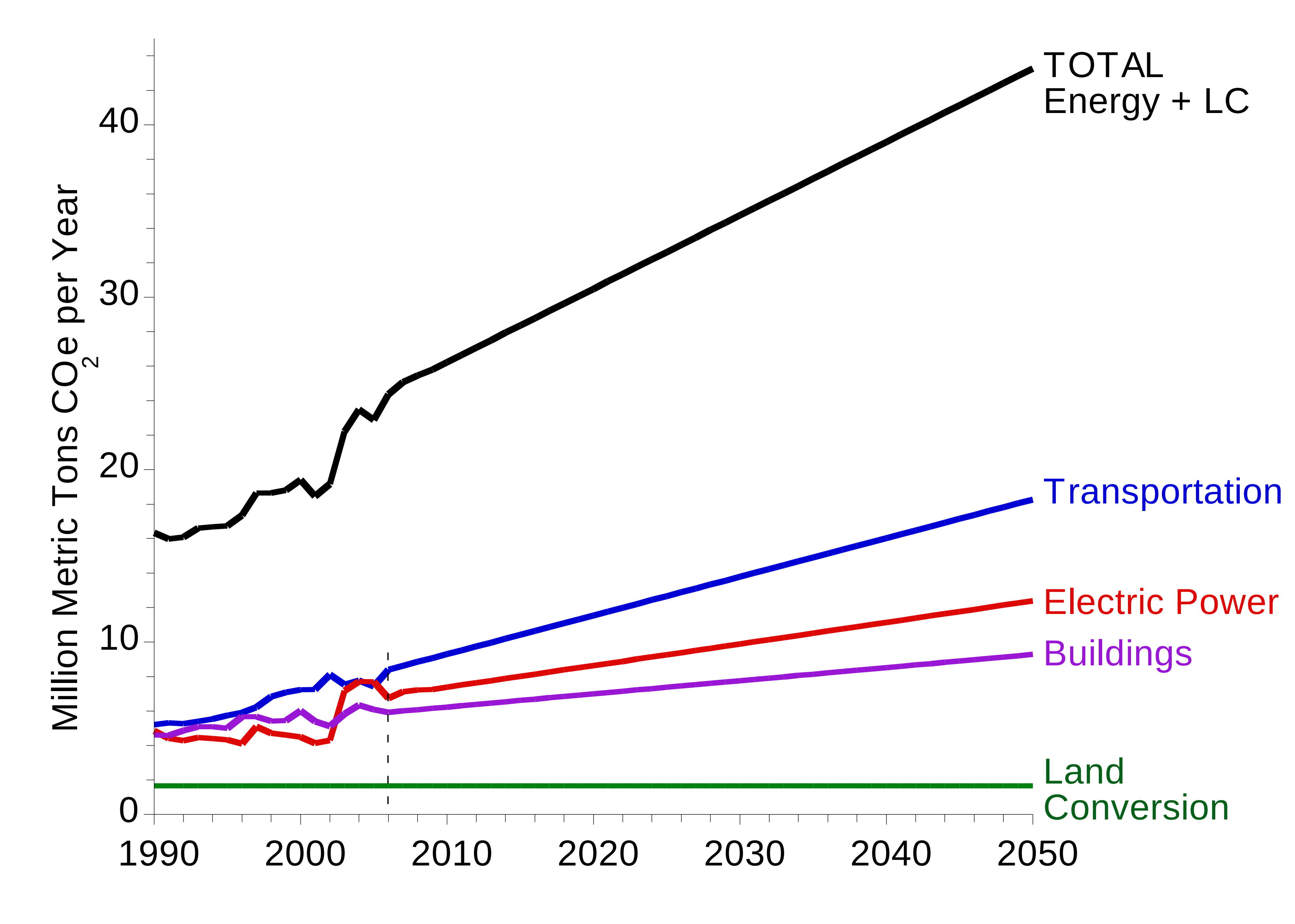

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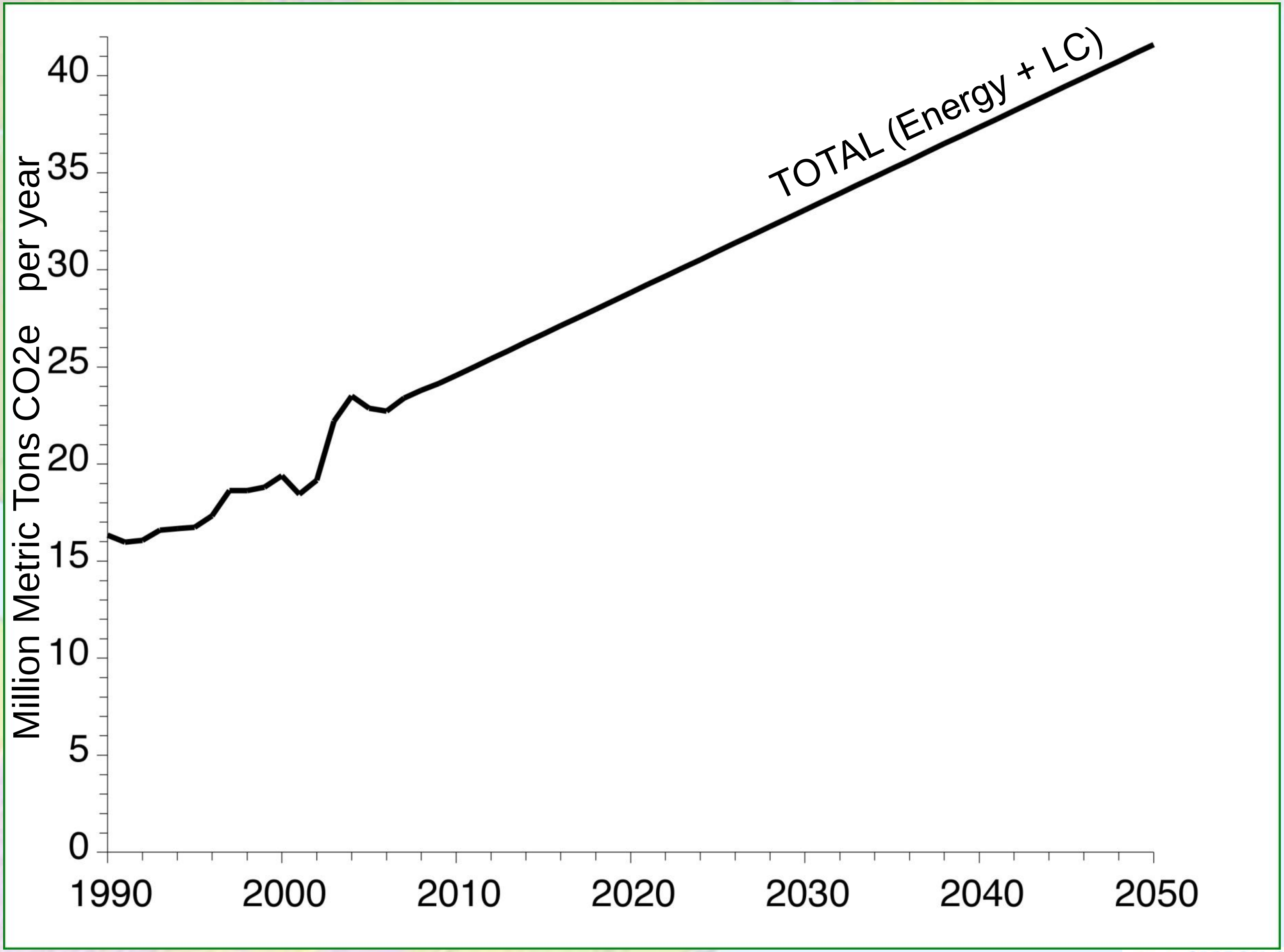

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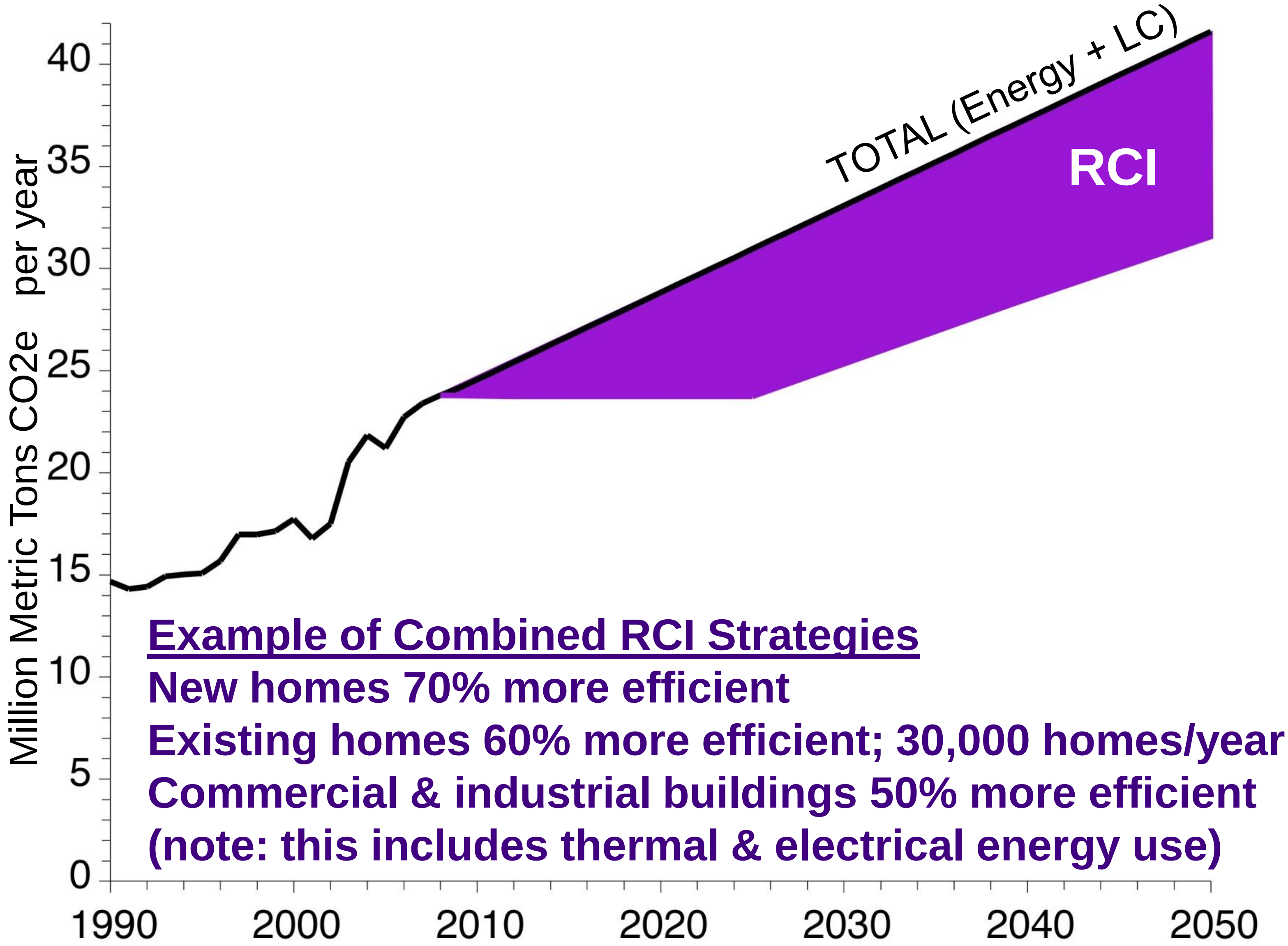
Estimated Greenhouse Gas Emission Reductions for NH



Example of Combined RCI Strategies

New homes 70% more efficient

Existing homes 60% more efficient; 30,000 homes/year

Commercial & industrial buildings 50% more efficient

(note: this includes thermal & electrical energy use)

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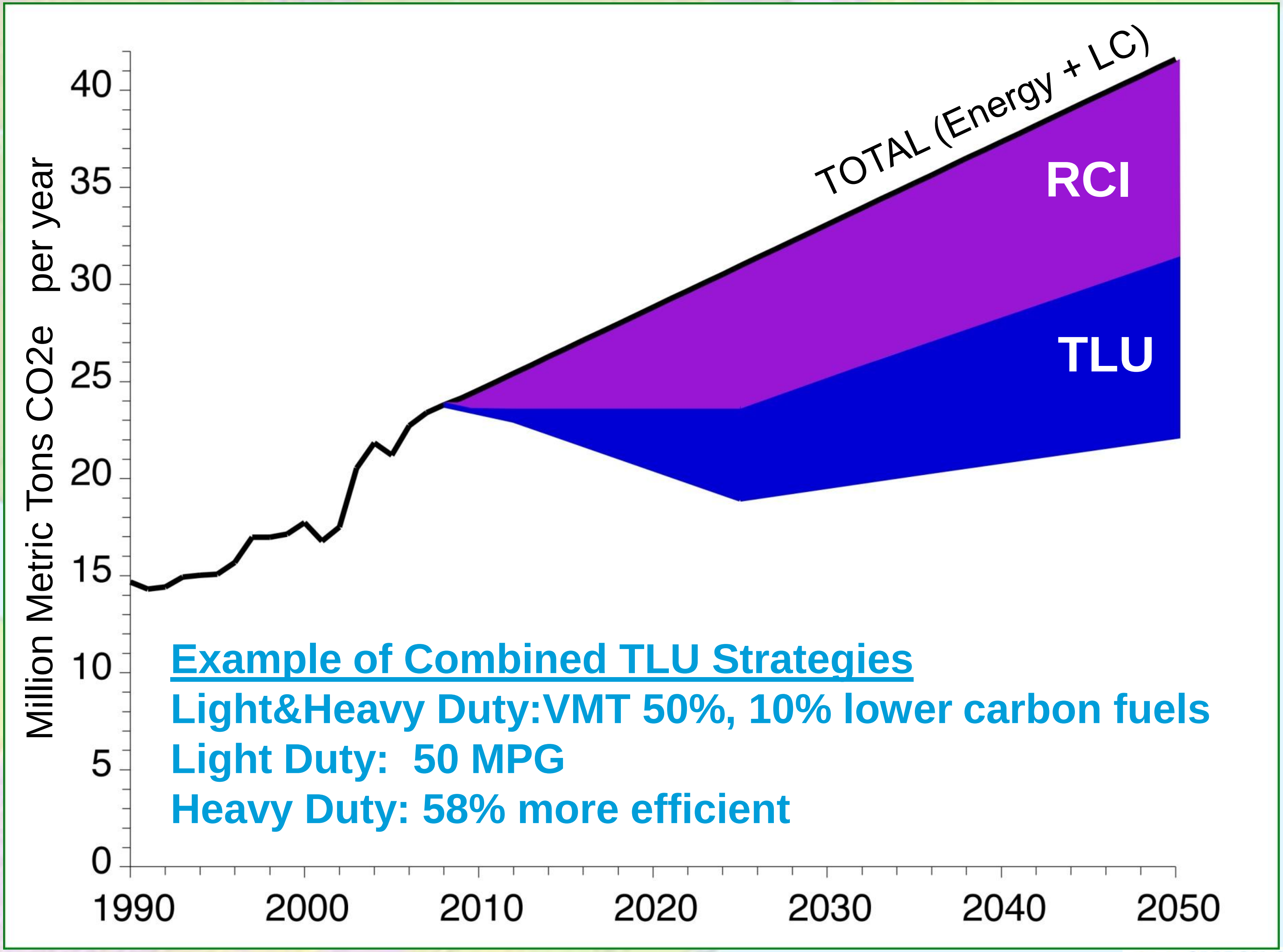

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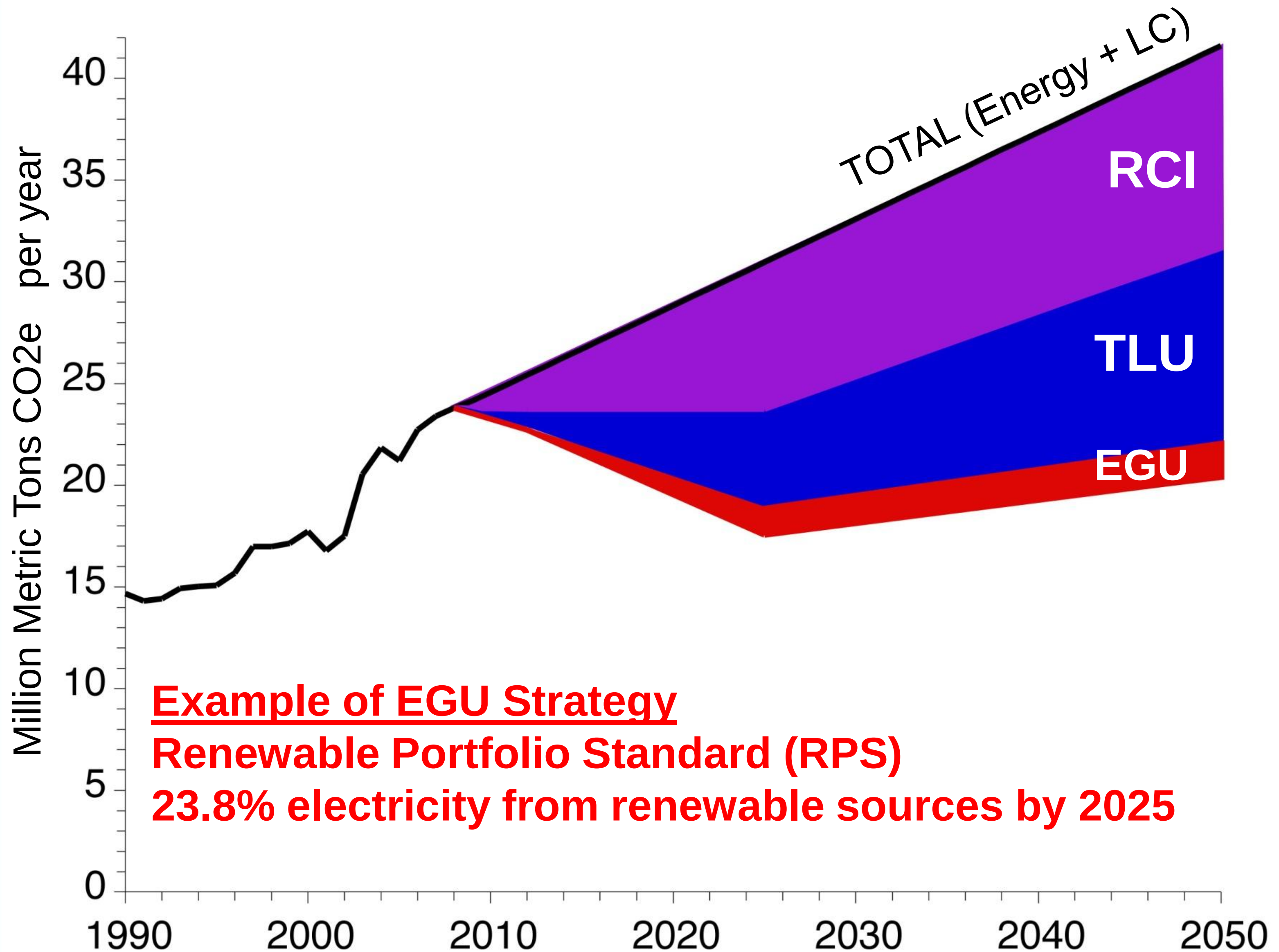

<u>Example of EGU Strategy</u>

Renewable Portfolio Standard (RPS)

23.8% electricity from renewable sources by 2025

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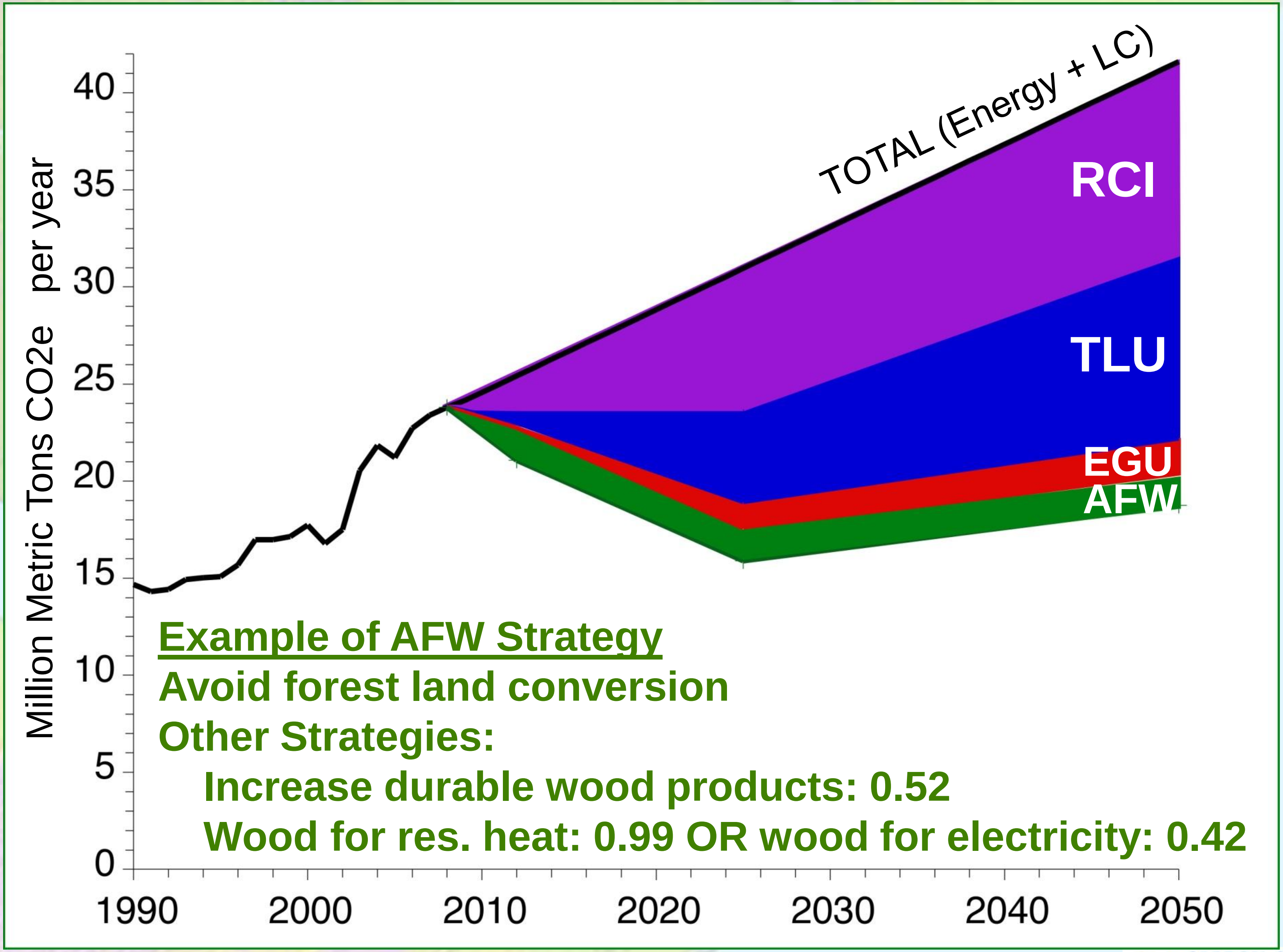

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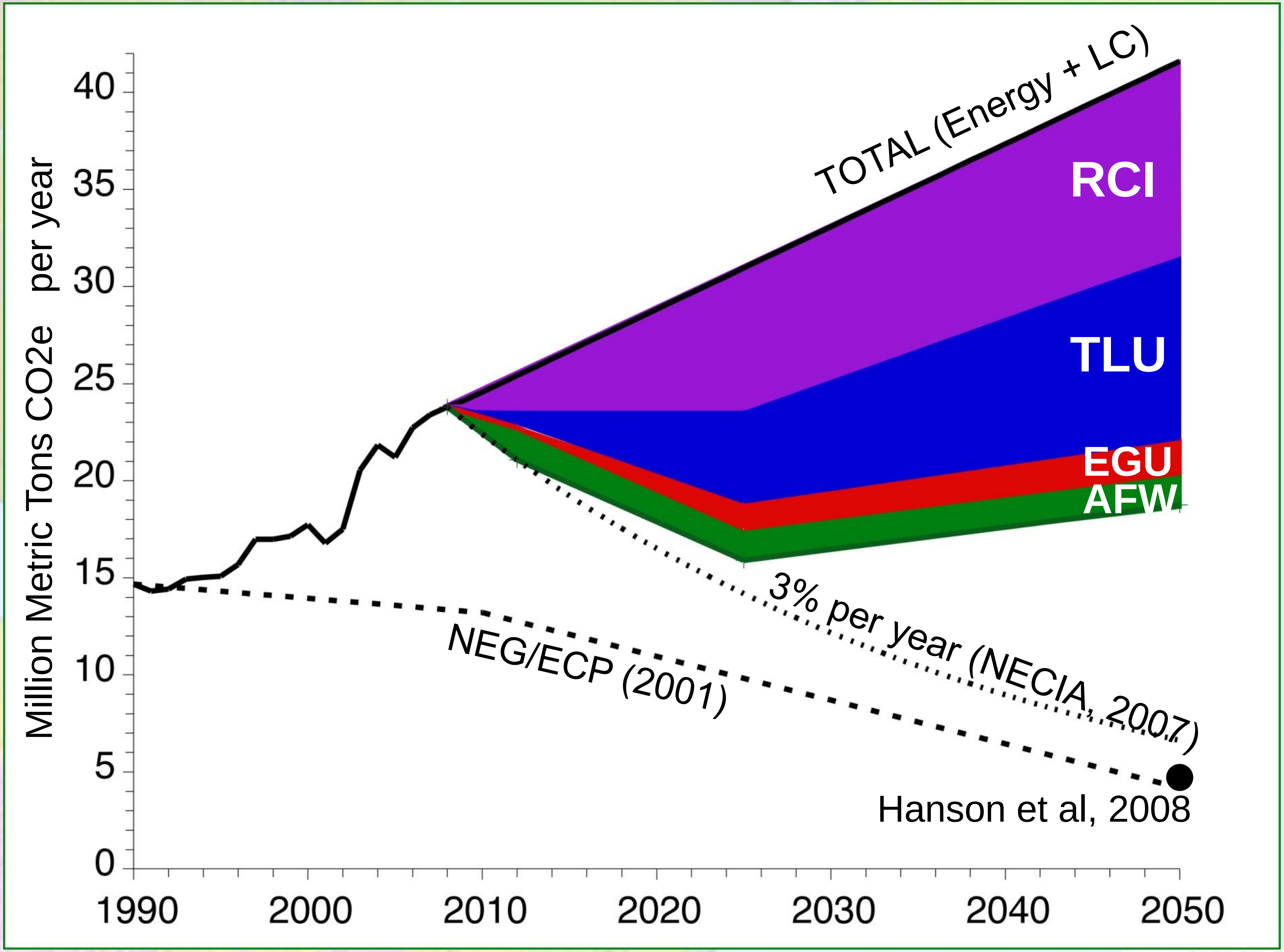
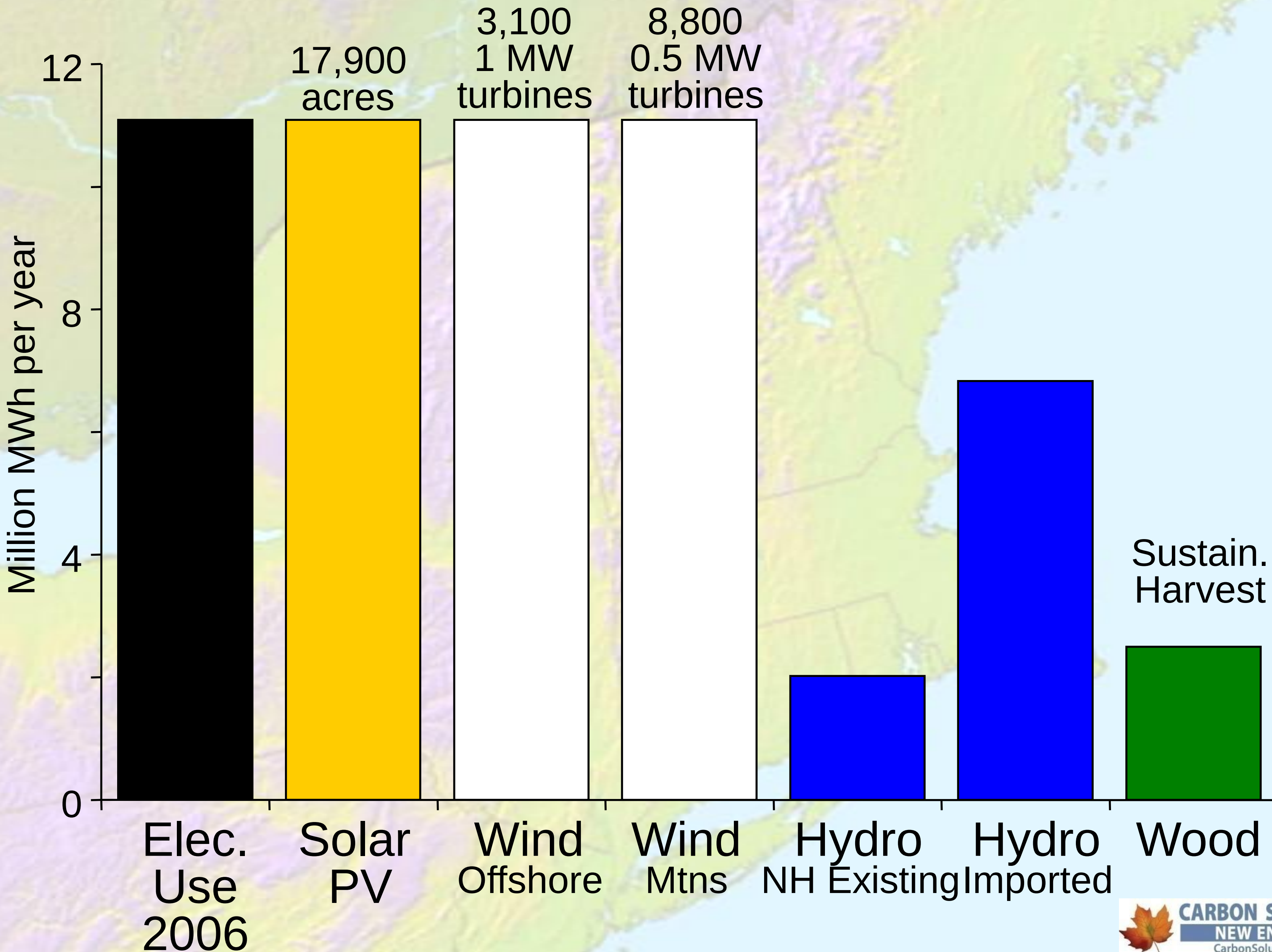


Theoretical NH Renewable Energy Potential Electrical Generation



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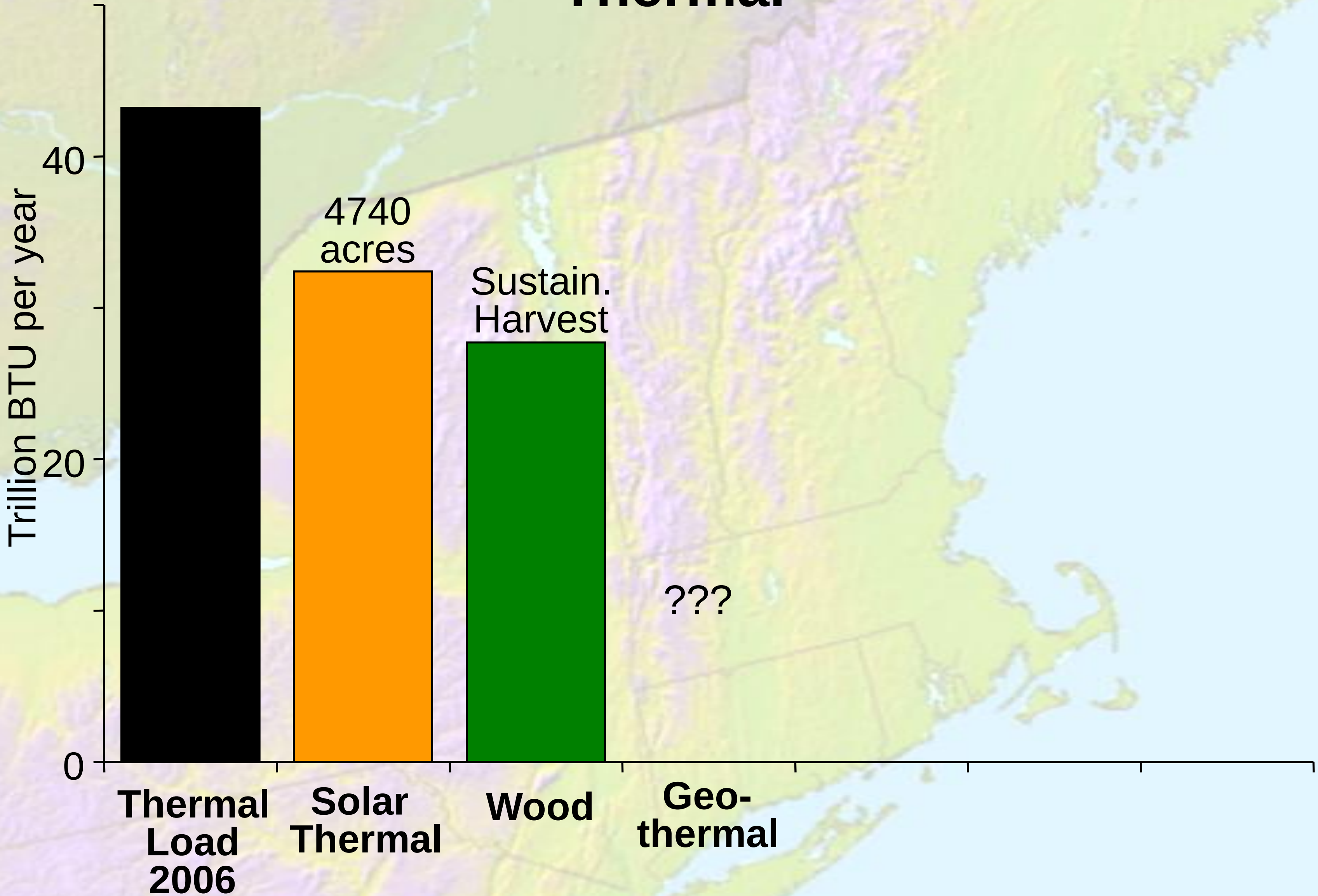
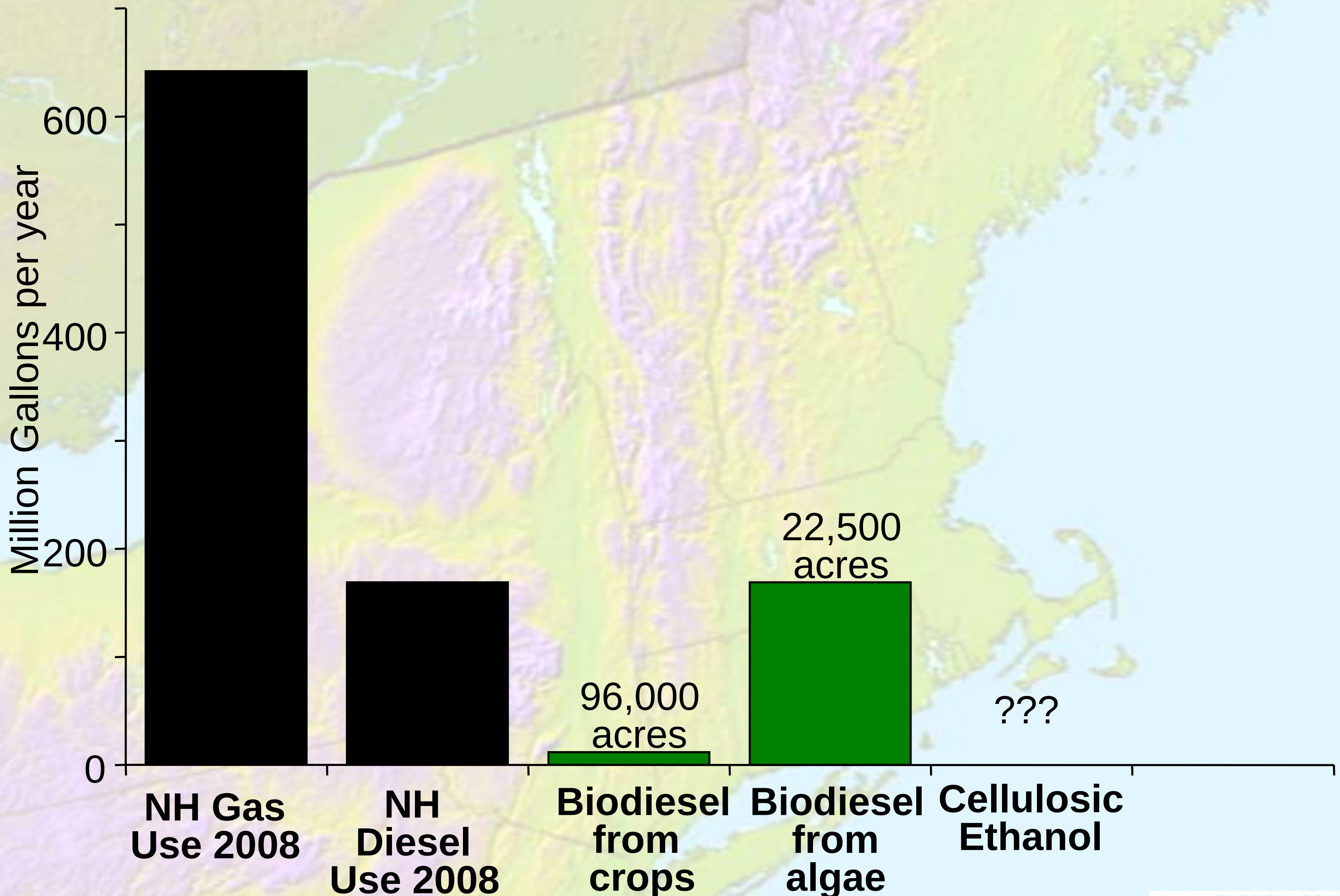
Theoretical NH Renewable Energy Potential Thermal



Theoretical NH Renewable Energy Potential Transportation



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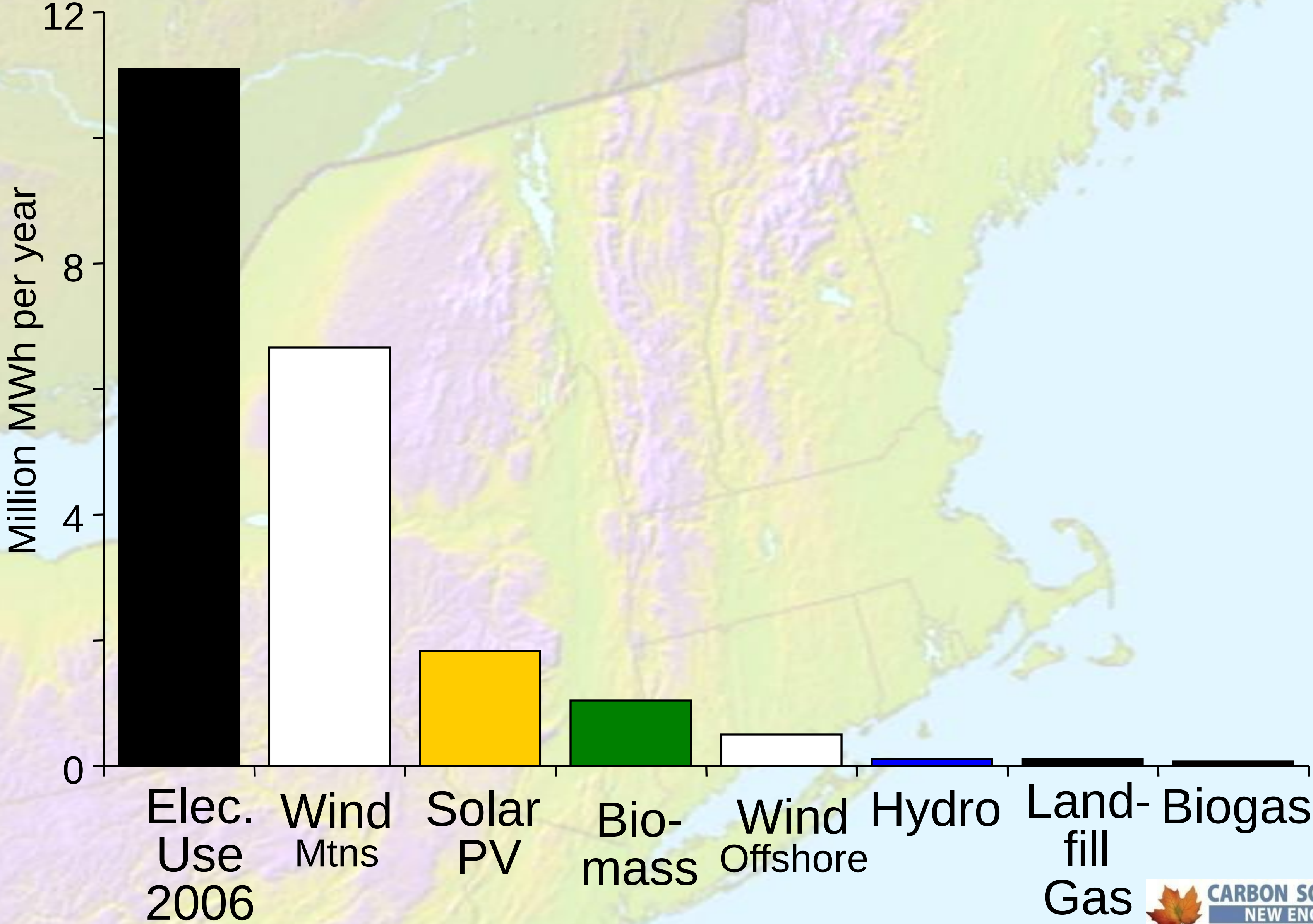
<u>Economic</u> NH Renewable Energy Potential (After NH RPS Analysis)



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3:15 PM	Task Force Next Steps

Summary of Economic Analysis for Proposed Actions by NH Climate Change Task Force

Ross Gittell, James R. Carter Professor
Matt Magnusson, MBA
8/11/2008

Economic Framing: *The "big picture" economic case for New Hampshire Climate Change Policies*

- Reduce dependence on imported energy & electricity
- Energy efficiency & in-state energy sources keeps $’s in the state
- Fosters business development and creates jobs
- Reduces risk and vulnerability to imported energy prices
- Reduces air pollution and environmental threats to key industries and the economy
  - *Protect natural resources*
  - *Maintain tourism*
  - *Attract skilled workforce/entrepreneurs*
  - *Reduce health care costs*

Given All the Options and Choices….
What are most favorable policies on an economic basis

- *Common Criteria used by economists:*
  - Lowest Costs and Highest Economic Benefits
  - Economic Benefits with….
    - relatively short-time frame to achieve
    - incentives to foster innovation and new businesses development and job creation
  - Economic Costs that are…
    - delayed, not all up-front
    - concentrated on those that contribute most to environmental damage and those best able to pay

Energy Efficiency examples

- Energy efficiency at the 24 percent improvements in efficiency *"low hanging fruit"* level
  - *Efficiency Standards*. Higher energy and electricity efficiency standards in industrial and new home and remodeling construction
  - *Code Enforcement* for existing and new buildings and homes (building and energy codes)
  - *Use of Smart Technology*. Promote through education and incentive programs more efficient energy and electricity use -- "smart" buildings and homes (e.g., programmable thermostats, smart appliances, etc.)

Transportation Examples

- Increased enforcement of vehicle speed limits
- Enhanced public transportation, e.g., bus services, commuter rail in high density travel corridors
- Low carbon fuel standard. Could be relatively low cost to consumers and provide incentives for innovation & business development

Forestry Example

- Promotion of wood products
- *This would be most cost effective if NH wood product suppliers are targeted*

Example.. Why does *increased enforcement of speed limits pass economic "test"?*

- At relatively low cost - provides ("stick") incentive for drivers to travel at speeds with higher energy efficiency
- Reduces resident and business expenditures on gasoline
- Keeps more $'s in the state to be "recycled in the economy"
- Fines stay in state as revenue for speed limit enforcement and other public purposes
- Other benefits: - reduced accidents (and associated health care costs and loss of lives) and increased fine revenue collected from out of state drivers

Methodology

- Given large number of policy options
  - took an "efficient analysis" approach to estimating the economic impacts of different actions
  - could not be as detailed as previous UNH economic studies of RPS and RGGI
- Limited to New Hampshire costs/benefits
- Analysis does not consider all the potential benefits such as reduced health costs due to reduced air pollution emissions

Methodology

- No discounting of costs and benefits of climate change policies to reflect timing or uncertainty
  - *consistent with approach for NH RGGI and RPS analysis and used in the Stern Report*
  - *Ken Arrow (2007) Nobel Laureate reviewed the Stern Report and concluded that discounting for time and uncertainty did not change conclusions*
- Economic benefits include the multiplier benefit of "recycling" of $'s in NH economy from renewal energy sources and energy efficiency savings replacing imported energy. *A conservative 1-1 multiplier is used (Federal Reserve Bank, 2002)*

Presentation of Economic Data

- Summary of the economic impacts of each action item under task force consideration
  - *<u>magnitude</u> of economic costs & benefits*
  - *<u>distribution</u> of economic costs & benefits*
  - *<u>timing</u> of costs & benefits*
- The economic analysis sections of each document provide detailed estimates and data of modeled costs and benefits of different policy options

Levels of Magnitude of Costs & Benefits

- **Low** - "0-$2.5 million"
- **Moderately Low** – "$2.5 million to $25"
- **Moderate** – "$25 million to $125 million"
- **Moderately high** – "$125 million to $500 million"
- **High** – "$500 million to $1 billion"
- **Very high** – "Greater than $1 billion"
- **Uncertain** – "Economic implementation costs were not easily determined"
- **Study** – "Means that the action proposed by the working group is a study to further look at issue, this is meant to avoid confusion in comparison of the costs of different actions"

Timing of Costs/Benefits

- **Immediate/higher upfront** –" The majority of economic cost is experienced in the relative short term with the longer term economic cost being less significant"
- **Constant/even** – "The economic cost tends to be relatively constant on an annual basis"
- **Low short-term/Mostly long-term** -" The majority of economic cost is experienced in the relative long term with the shorter term economic cost being less significant"
- **Uncertain-** "Economic implementation costs were not easily determined without more research"

Distribution: *Who benefits? Who pays?*

- **Consumer/Households** (evenly distributed, concentrated on particular groups)
- **Government** (state, local)
- **Business** (evenly distributed, concentrated on particular types)

Energy Price Forecast Considerations and Potential Analytical Adjustment

- (2008) US-DOE EIA (Energy Information Administration) Energy Outlook in constant $2008
- EIA forecasts are low
- In general, economic benefits would increase from the presented "base case" with the energy prices in similar direction but 1/3rd to 1/4 less than on a full percentage basis

For Example

If gasoline prices were 33 percent higher than assumed the economic benefits/value of speeding ticket enforcement would go up a bit less than 33 percent (or about 25%)

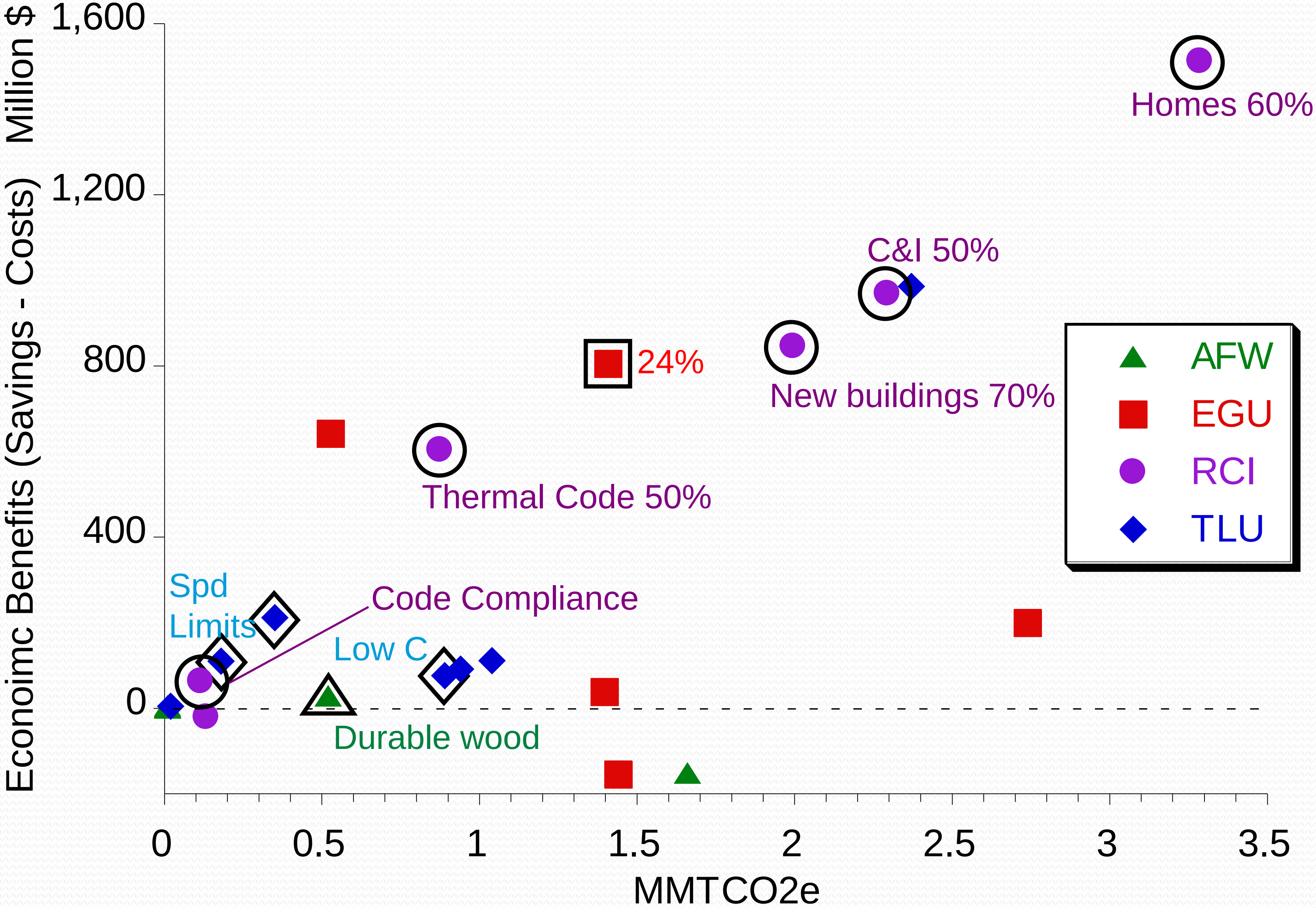
It would go up less than the percentage change in gas price because of reduced speeding and travel induced by high market price

Fuel Forecast

- Based on EIA Annual Energy Outlook 2008 in constant $2008

	Units	2012	2025	2050
LPG	Gallon	$ 1.87	$1.89	$ 1.97
Residual Oil	Gallon	$ 1.48	$1.44	$ 1.57
Distillate Oil	Gallon	$ 2.59	$2.61	$ 2.78
Natural Gas	Therm	$ 0.87	$0.90	$ 0.99
Electricity- NH Specific	kWh	$ 0.15	$0.15	$ 0.15
Motor Gasoline	Gallon	$ 2.76	$2.71	$ 2.80
Diesel Fuel (distillate fuel oil)	Gallon	$ 2.75	$2.75	$ 2.91

CO2 and Economic Benefits in 2025



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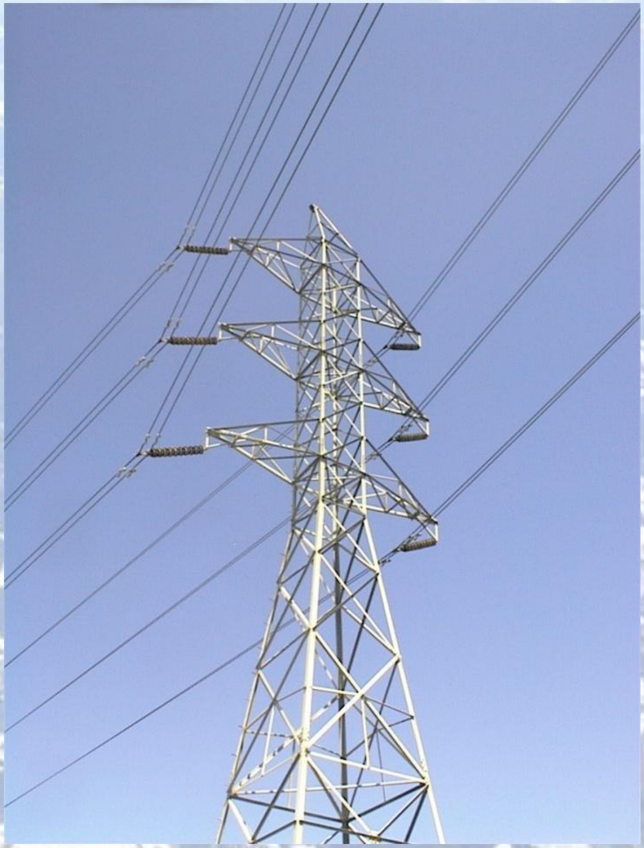
Electricity Generation and Use: Emissions Model

<u>NH Generation Model</u>:

- Based on projection of future generation (MWh) and fuel mix

• **BAU:**

- Maintain current NH generation base
- Linear projection of NE generation growth, NH maintains 17.3% share
- New generation from natural gas



<u>NH Consumption Model</u>:

- Calculated using the ISO-NE marginal emissions factor
- Emissions savings applied to NH generation emissions

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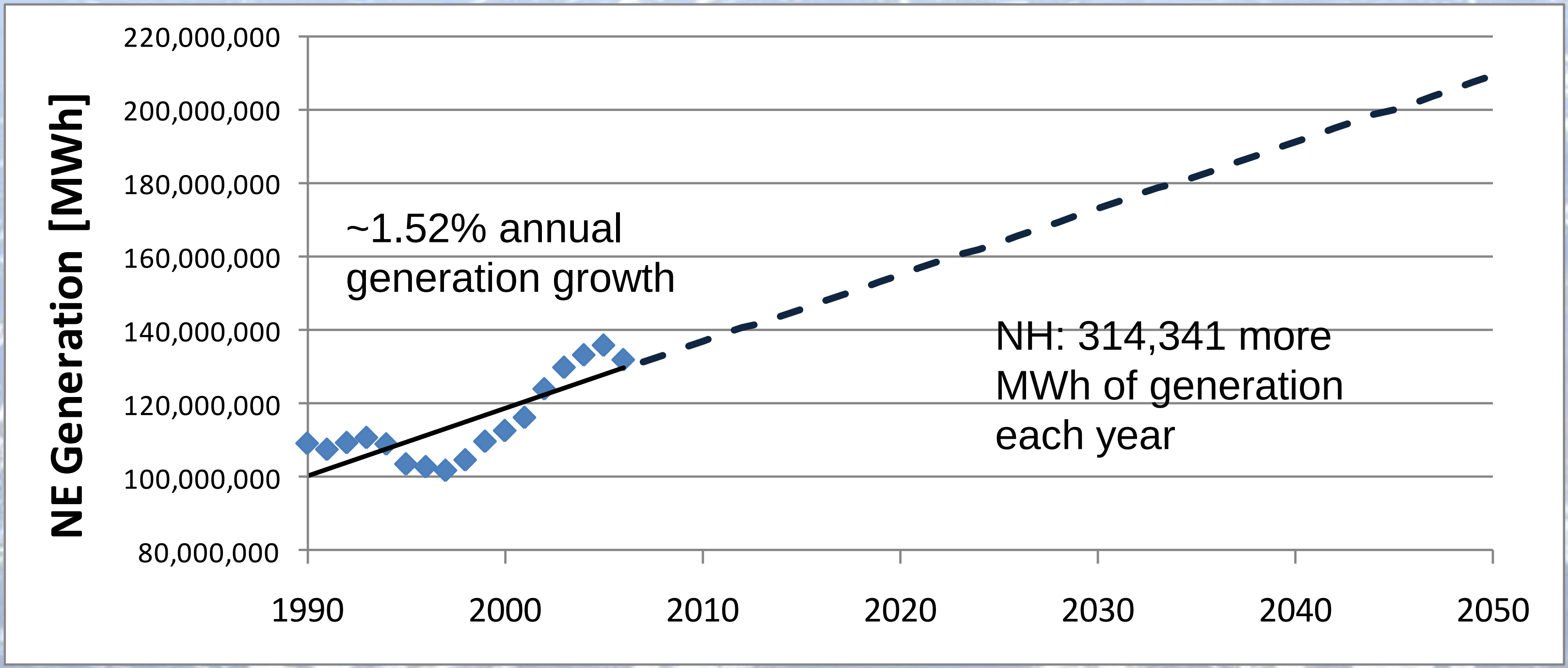
Electricity Generation and Use: Example Calculation

New Source Performance Standard:

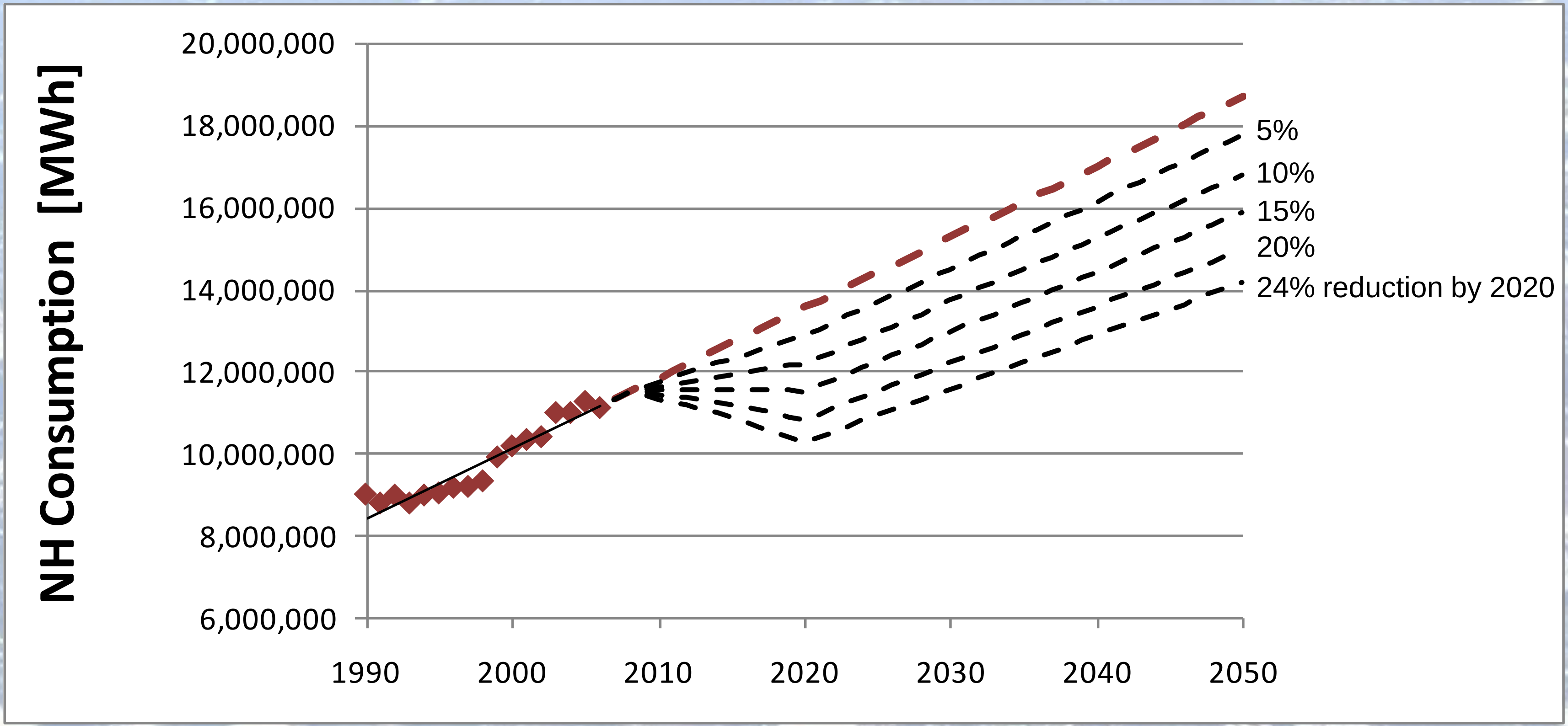
- NH maintains 17.3% share of NE generation
- BAU: new generation above existing capacity is Natural Gas
- Natural Gas Emissions Factor = 878 lbs CO_2/MWh
- NSPS: 800, 700, 600, 500, 400, 300, 250 lbs CO_2/MWh



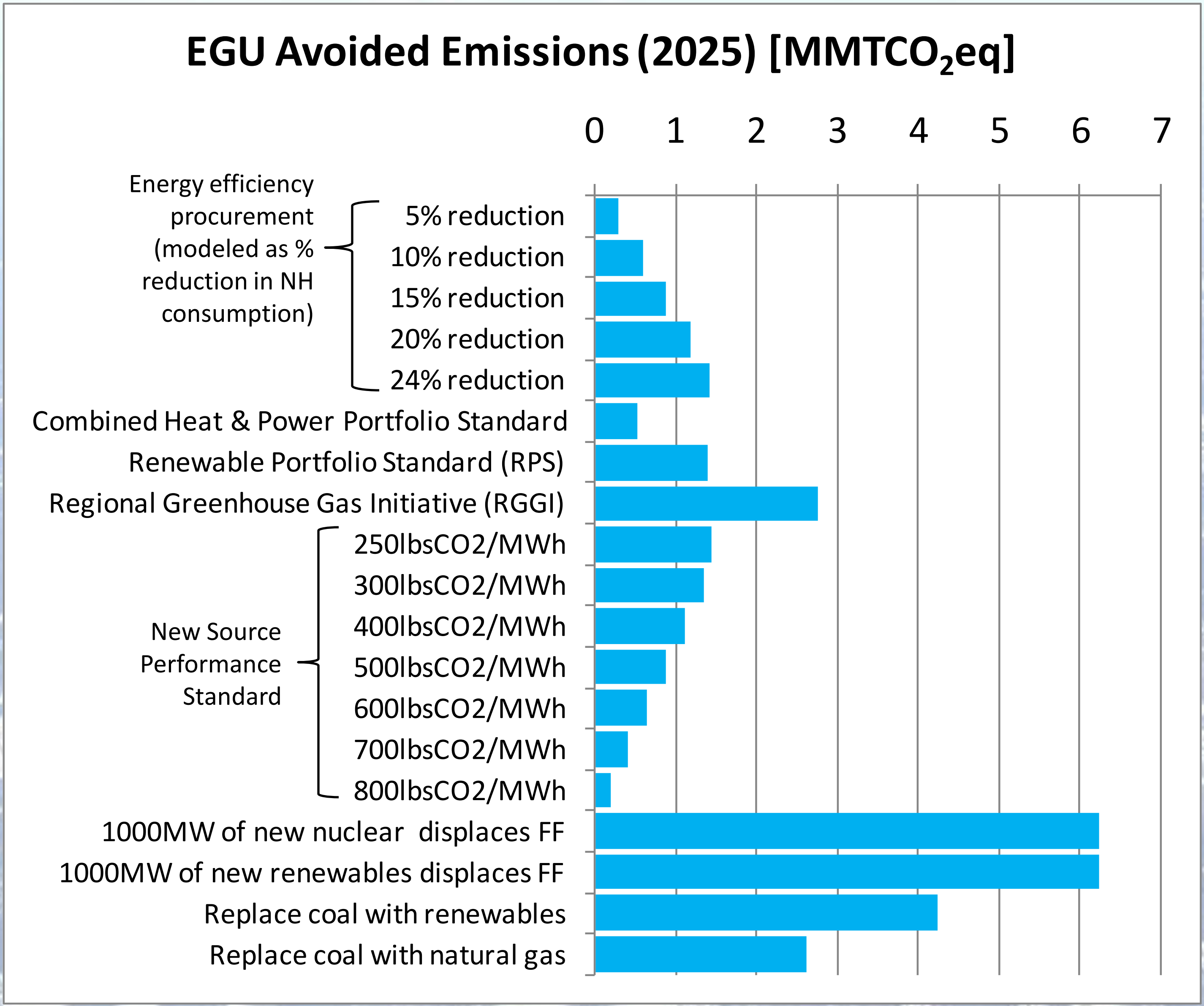
Electricity Generation and Use: Example Calculation

Energy Efficiency Procurement:
- Based on % reductions in BAU NH electricity consumption by 2020
- Emissions savings from NE Marginal Emissions Factor

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011-2050
NE Marginal emissions factor [lbs CO2/MWh]	1,488	1,394	1,338	1,179	1,102	1,107	*1,063*	*1,028*	*994*	*961*	*930*	*899*



Electricity Generation and Use: Avoided Emissions



BAU Electricity Generation Emissions (2025) = 9.26

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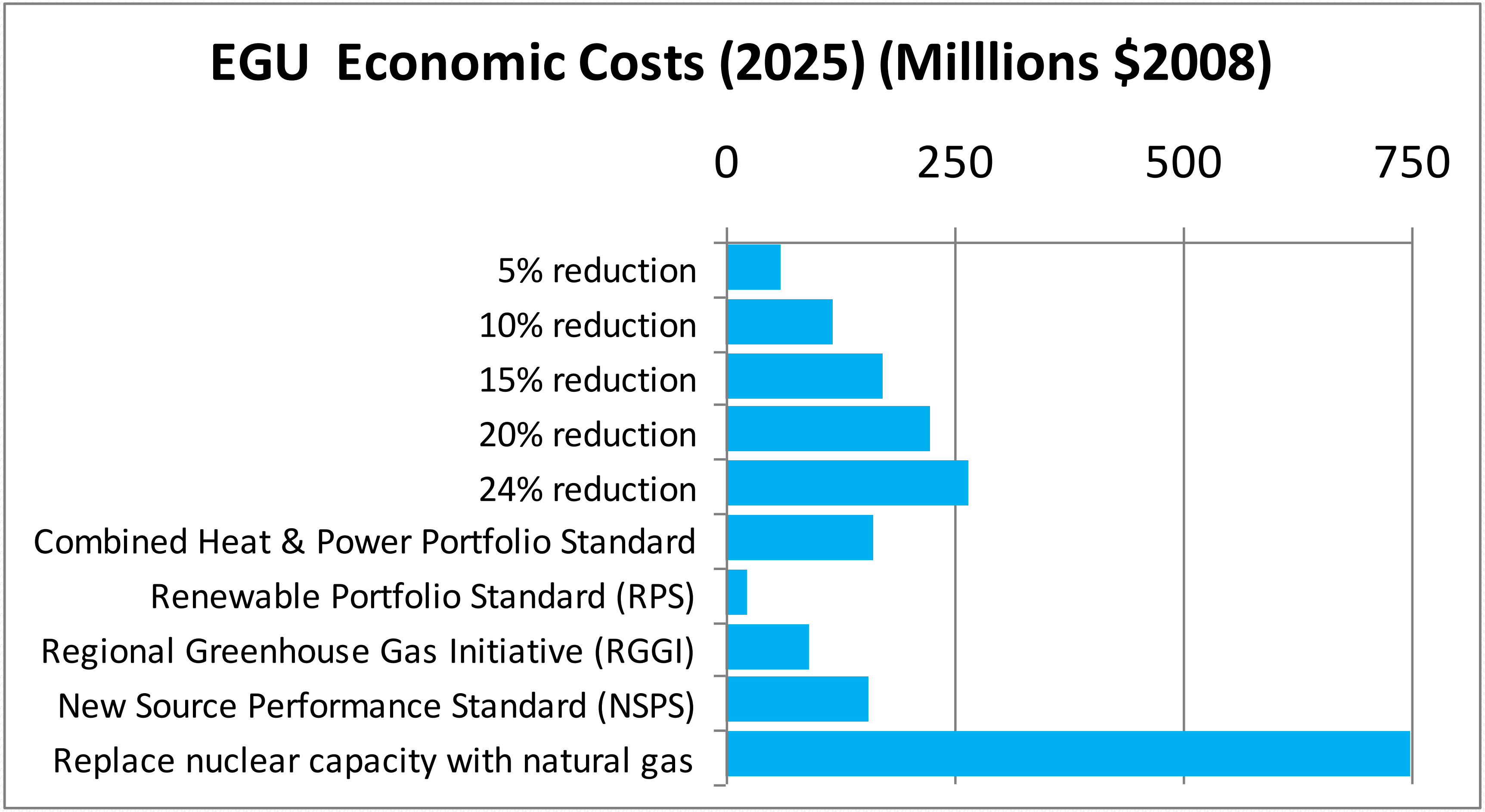
Overview of EGU Policies

- The majority of actions proposed had significant economic benefits expected as a result of their implementation

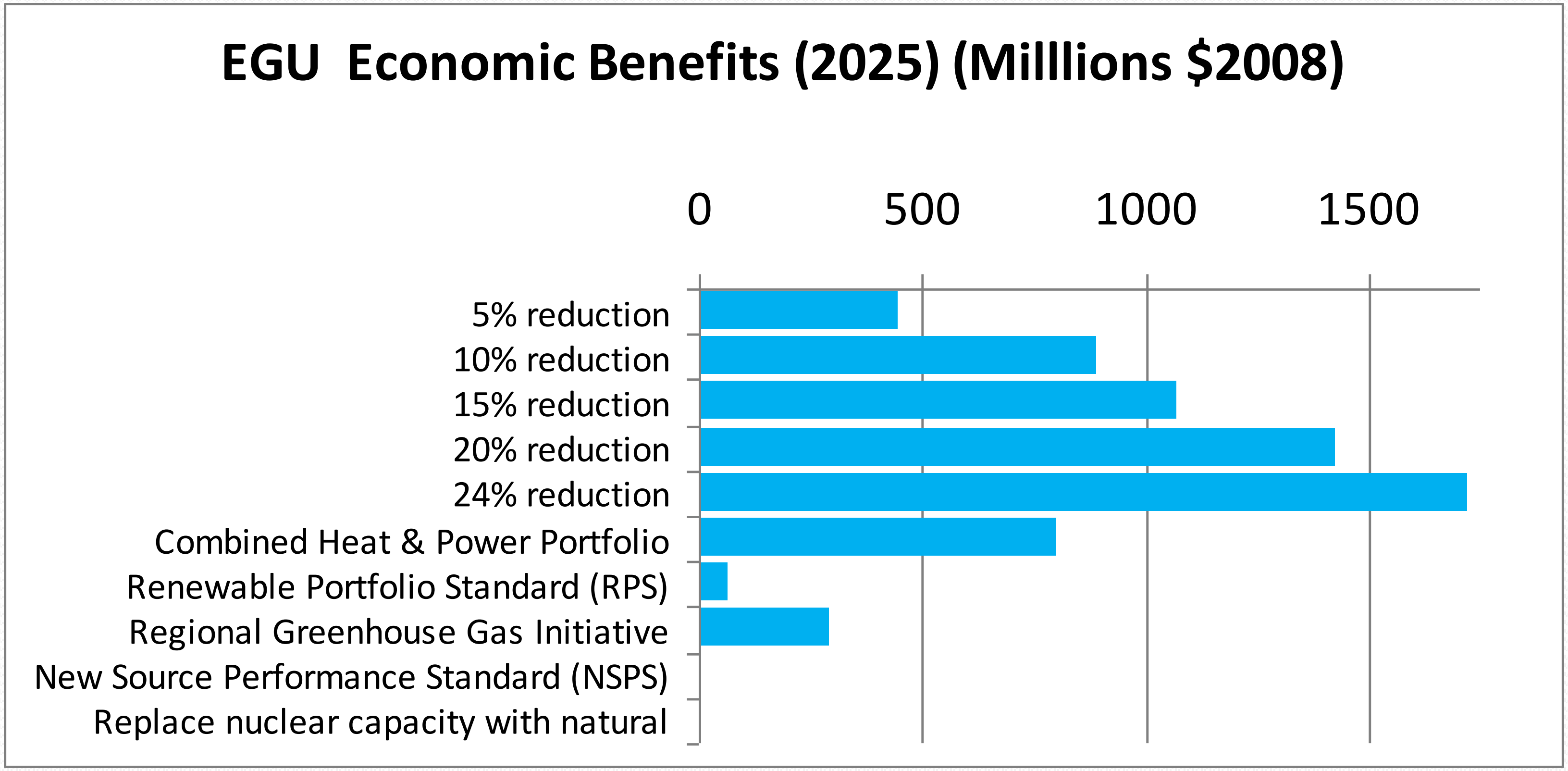
- Most significant proposed action in terms of total economic benefits was Action 1.2 Energy Efficiency Procurement (24%)- ~$1.7 billion in economic benefits annually in NH by 2025

- Examples of policies that appear to meet economic "criteria"
  - Action 1.2 Energy Efficiency Procurement - 5% reduction in NH consumption by 2020
  - Action 1.3 Combined Heat & Power Portfolio Standard
  - Action 2.2 Regional Greenhouse Gas Initiative (RGGI)

EGU Annual Implementation Costs



EGU Annual Economic Benefits

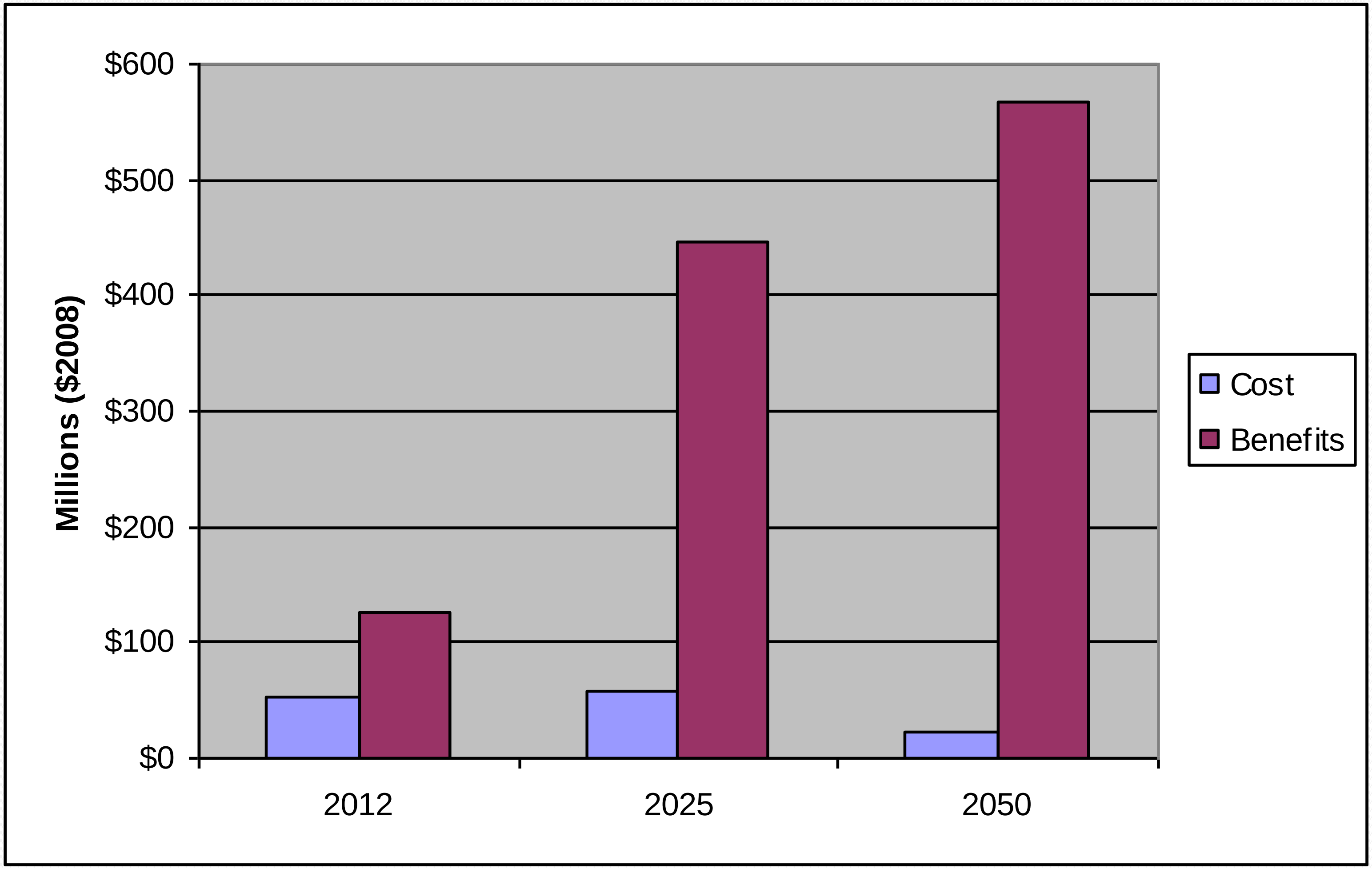


Illustrative Example:
Action 1.2 Energy Efficiency Procurement (5%)

- Cost Calculation
  - Energy Efficiency/Demand Response assumed to average $0.035 per avoided kWh (Northeast Energy Efficiency Partnership)
  - Avoided kWhs based on CSNE carbon model
  - EE 14 year lifetime (NH Core programs)
  - Total annual cost of $59 million in 2025
- Benefits Calculation
  - Savings based on avoided retail cost of electricity (ISO NE CELT 2008 Forecast) - ~ $0.15 per kWh
  - $1 multiplier based on electricity savings
  - Total annual economic benefits of $450 million in 2025

Illustrative Example:

Action 1.2 Energy Efficiency Procurement (5%)



Illustrative Example: (Continued)

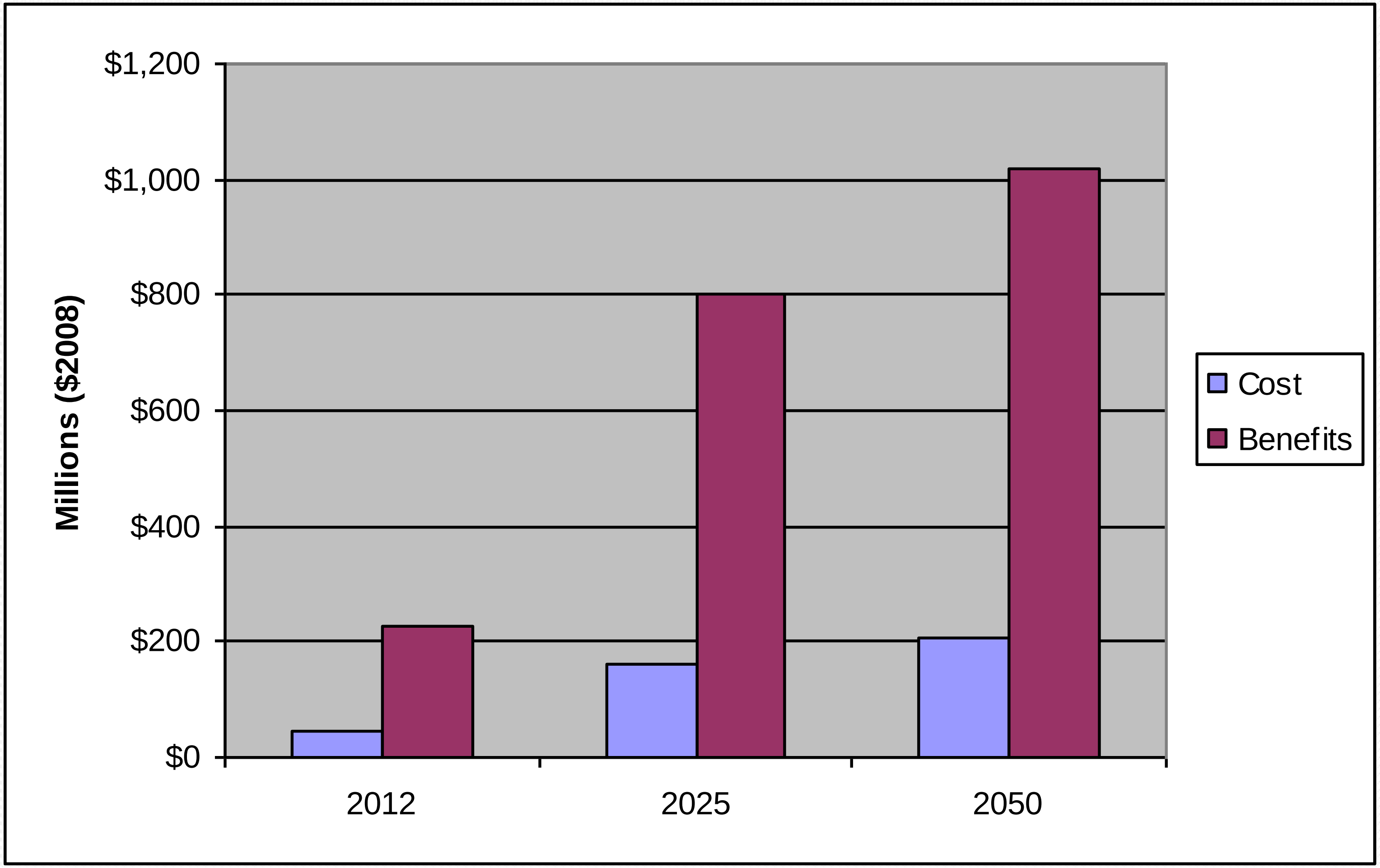
Action 1.2 Energy Efficiency Procurement (5%)

- Costs
  - Implementation Cost– Moderate "$25 -$125 million"
  - Timing of Costs – Immediate/higher upfront
  - Impacted – Evenly Distributed
- Economic benefits
  - Potential benefits– High "$0.5 - $1 billion"
  - Timing of Benefits– Low short-term/Mostly long-term
  - Impacted – Evenly Distributed

Illustrative Example:
Action 1.3 Combined Heat & Power Standard

- Cost Calculation
  - Levelized cost of CHP assumed to average $0.06 per kWh (US EPA)
  - kWhs required to meet standard based on CSNE carbon model
  - Total annual cost of $160 million in 2025
- Benefits Calculation
  - Savings based on avoided retail cost of electricity (ISO NE CELT 2008 Forecast) - ~ $0.15 per kWh
  - $1 multiplier based on electricity savings
  - Total annual economic benefits of $800 million in 2025

Illustrative Example:
Action 1.3 Combined Heat & Power Standard



Illustrative Example: (Continued)
Action 1.3 Combined Heat & Power Standard

- Costs
  - Implementation Cost– Moderate "$25 -$125 million"
  - Timing of Costs – Low short-term / Mostly long-term
  - Impacted – Evenly Distributed
- Economic benefits
  - Potential benefits– High "$0.5 - $1 billion"
  - Timing of Benefits– Low short-term/Mostly long-term
  - Impacted – Business – Evenly Distributed

Illustrative Example:
Action 1.1 Decoupling

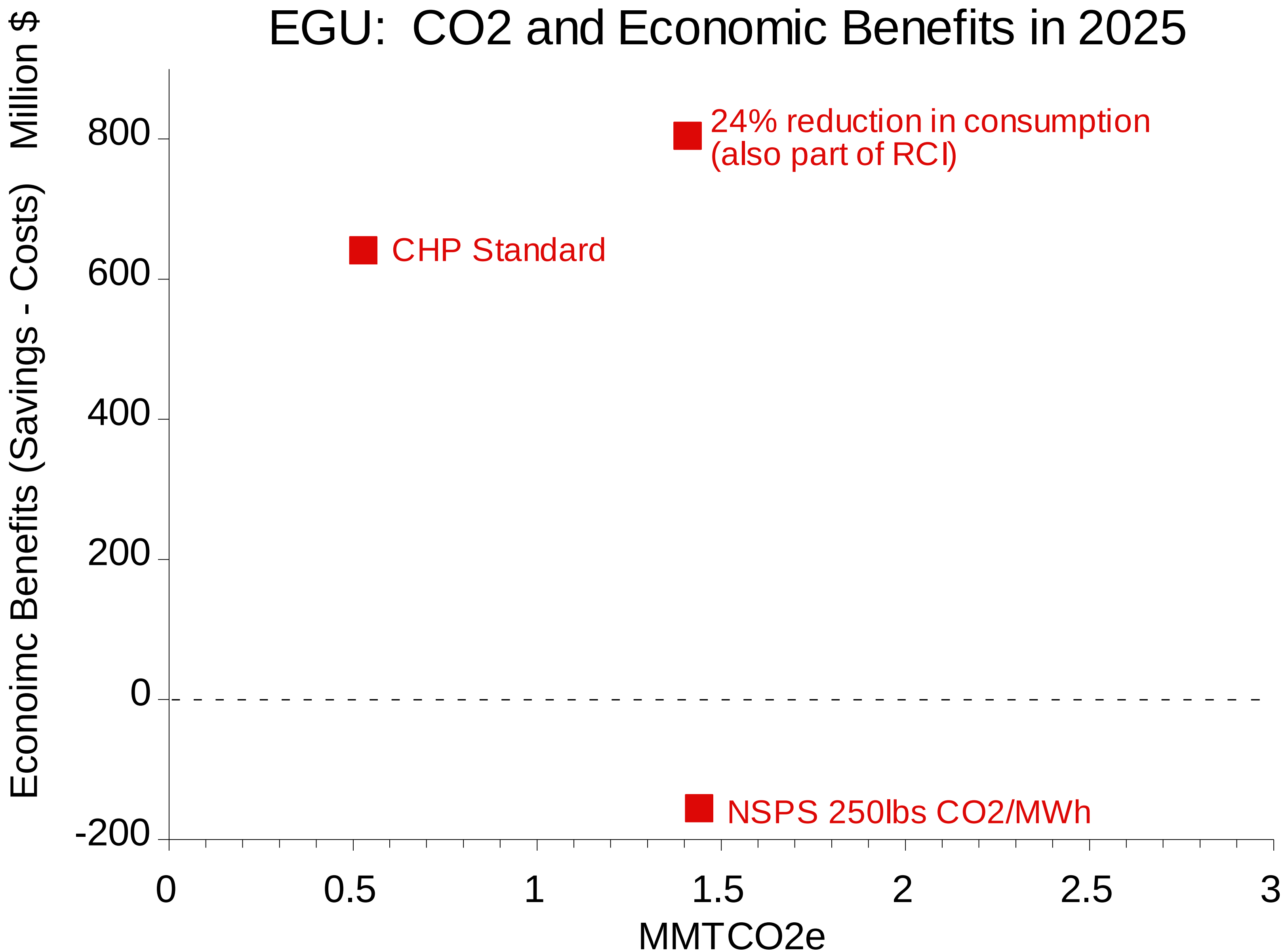
- Cost Calculation
  - Literature review could not provide reasonable assumptions to quantify the reduction in “barriers” to energy efficiency
  - $60,000 annually for administration (UNH economic team)

- Benefits Calculation
  - Not calculated

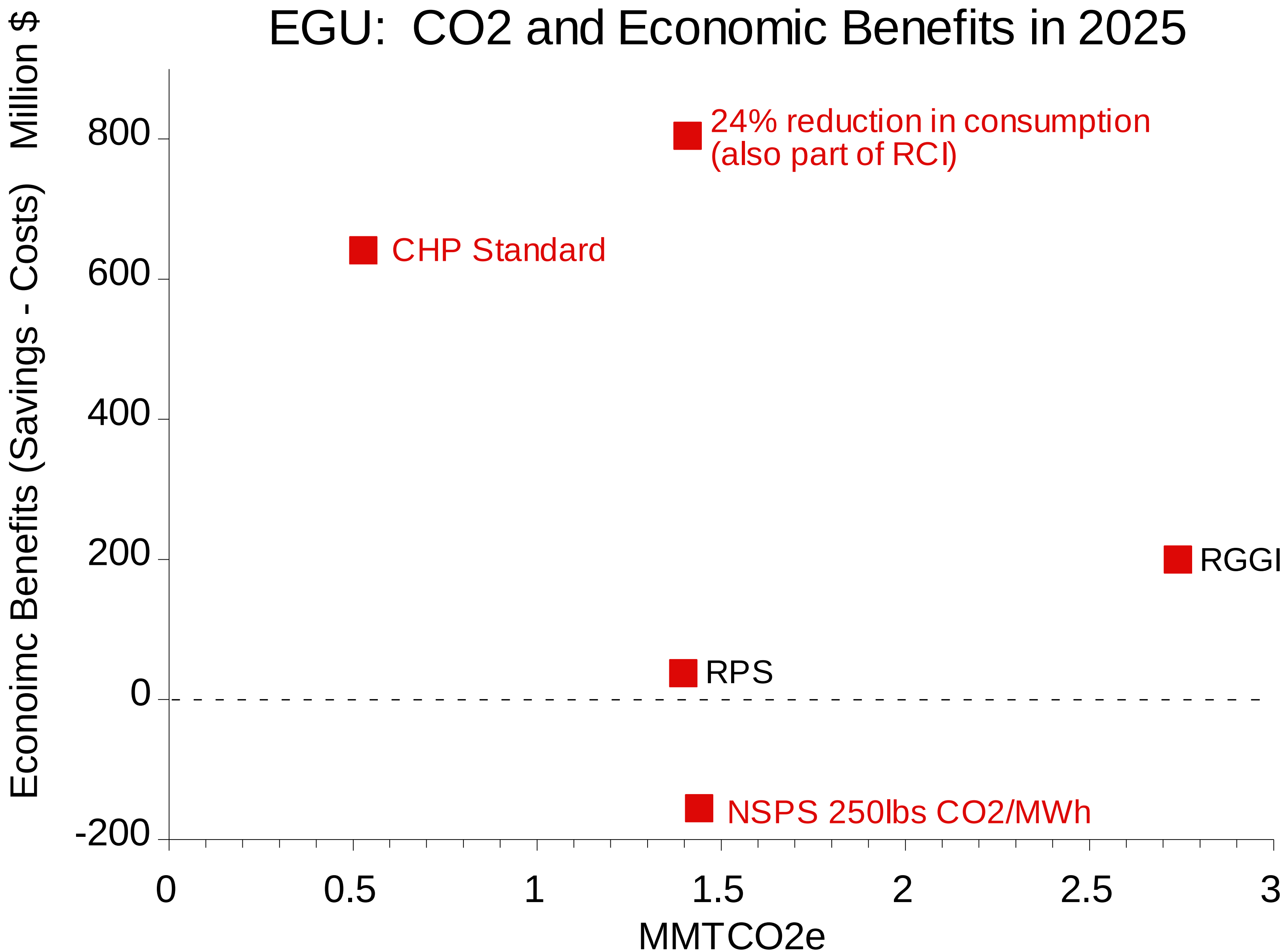
Illustrative Example: (Continued)

Action 1.1 Decoupling

- Costs
  - Implementation Cost– Low “$0-$2.5 million”
  - Timing of Costs – Constant/Even
  - Impacted – Government - State
- Economic benefits
  - Supporting mechanism for energy efficiency procurement



EGU: CO2 and Economic Benefits in 2025
Economic Benefits (Savings - Costs)   Million $
800
600
400
200
0
-200
0
0.5
1
1.5
2
2.5
3
MMTCO2e
24% reduction in consumption
(also part of RCI)
CHP Standard
NSPS 250lbs CO2/MWh



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24% reduction in consumption
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CHP Standard
RGGI
RPS
NSPS 250lbs CO2/MWh

Residential, Commercial, and Industrial: Emissions Model

Residential Model:
- Based on energy intensity per capita and NH population growth
- Thermal energy mix + non-thermal electricity

Commercial Model:
- Based on energy intensity per sq ft and NH floorspace growth
- Thermal energy mix + non-thermal electricity

• ***Residential and Commercial BAU:***
- Maintain current energy intensity and fuel mix and apply to growing population and floorspace

Industrial Model:
- No projected growth
- **BAU**: maintain recent historical average fuel use

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Residential, Commercial, and Industrial: Example Calculation

Maximize Efficiency in New Construction:

- Residential

Energy consumption and fuel profile

Average annual thermal consumption [million BTU / person] =	40.1
Average annual non-thermal electric consumption [million BTU / person] =	8.7
Thermal fuel profile	
Electric	7.5%
Coal	0.0%
Natural gas	15.0%
Distillate fuel	52.3%
Kerosene	6.0%
LPG	14.2%
Wood	5.1%

Population

	2000	2010	2020	2030	2040	2050
Population	1,247,342	1,356,521	1,465,700	1,574,879	1,684,058	1,793,237
Average annual growth		0.88%	0.80%	0.74%	0.69%	0.65%

+ 0.5% annual building turnover

Residential, Commercial, and Industrial: Example Calculation

Maximize Efficiency in New Construction:

- Commercial

Energy consumption and fuel profile

Average annual thermal consumption [thousand BTU / sqft] =	94.2
Average annual non-thermal electric consumption [thousand BTU / sqft] =	30.0
Thermal fuel profile	
Thermal electric	14.0%
Coal	0.3%
Natural gas	29.4%
Distillate fuel	26.5%
Kerosene	1.2%
LPG	3.8%
Motor gasoline	0.3%
Residual fuel	23.3%
Biomass	1.2%

Commercial floorspace

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Number of commercial buildings	19,902	24,736	29,571	34,405	39,240	44,074
Commercial floorspace [thousand sqft]	321,417	399,496	477,575	555,654	633,733	711,811

+ 0.5% annual building turnover

Residential, Commercial, and Industrial: Example Calculation

<u>Maximize Efficiency in New Construction</u>:

- Residential and Commercial Emissions

Direct fuel use emissions

Emissions factor [lbCO2e/million BTU]	
Coal	225.130
Natural gas	117.080
Distillate fuel	161.386
Kerosene	159.535
LPG	139.039
Motor gasoline	156.425
Residual fuel	173.906
Wood	0.000

Electricity emissions

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011-2050
NE Marginal emissions factor [lbs CO2/MWh]	1,488	1,394	1,338	1,179	1,102	1,107	*1,063*	*1,028*	*994*	*961*	*930*	*899*

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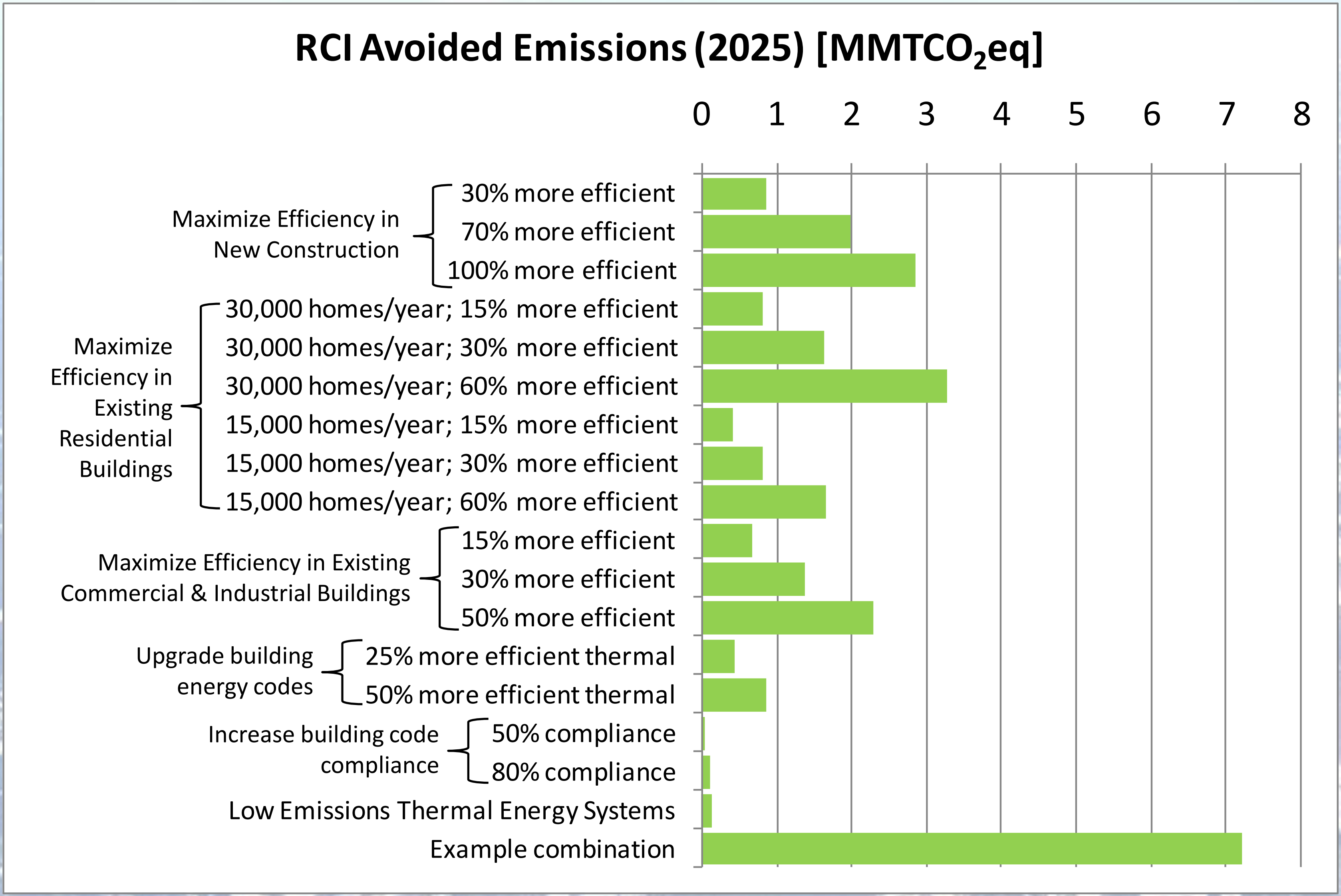
Residential, Commercial, and Industrial: Avoided Emissions



BAU RCI non-electric (2025) = 7.37 ; BAU EG (2025) = 9.26

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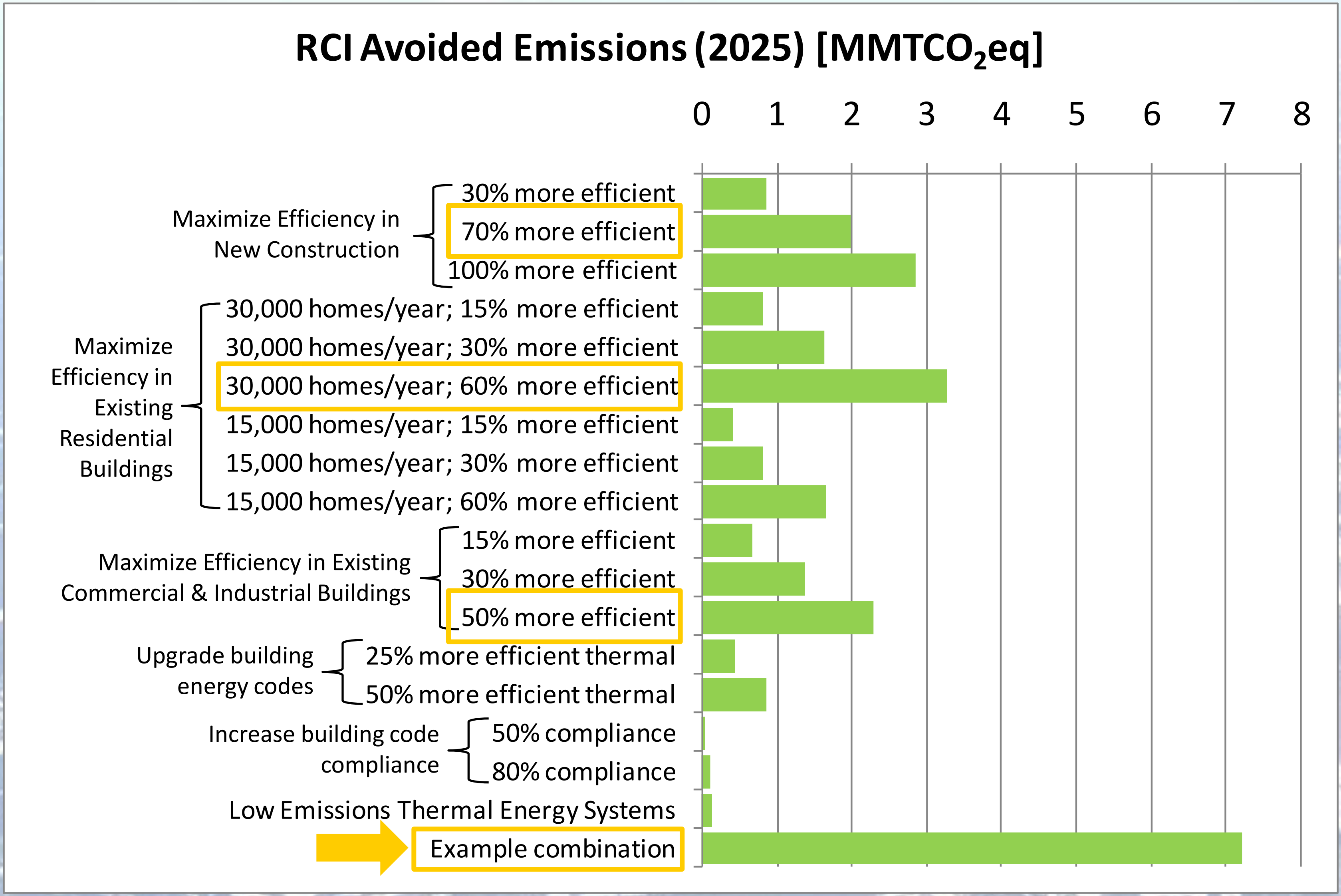
Residential, Commercial, and Industrial: Avoided Emissions



BAU RCI non-electric (2025) = 7.37 ; BAU EG (2025) = 9.26

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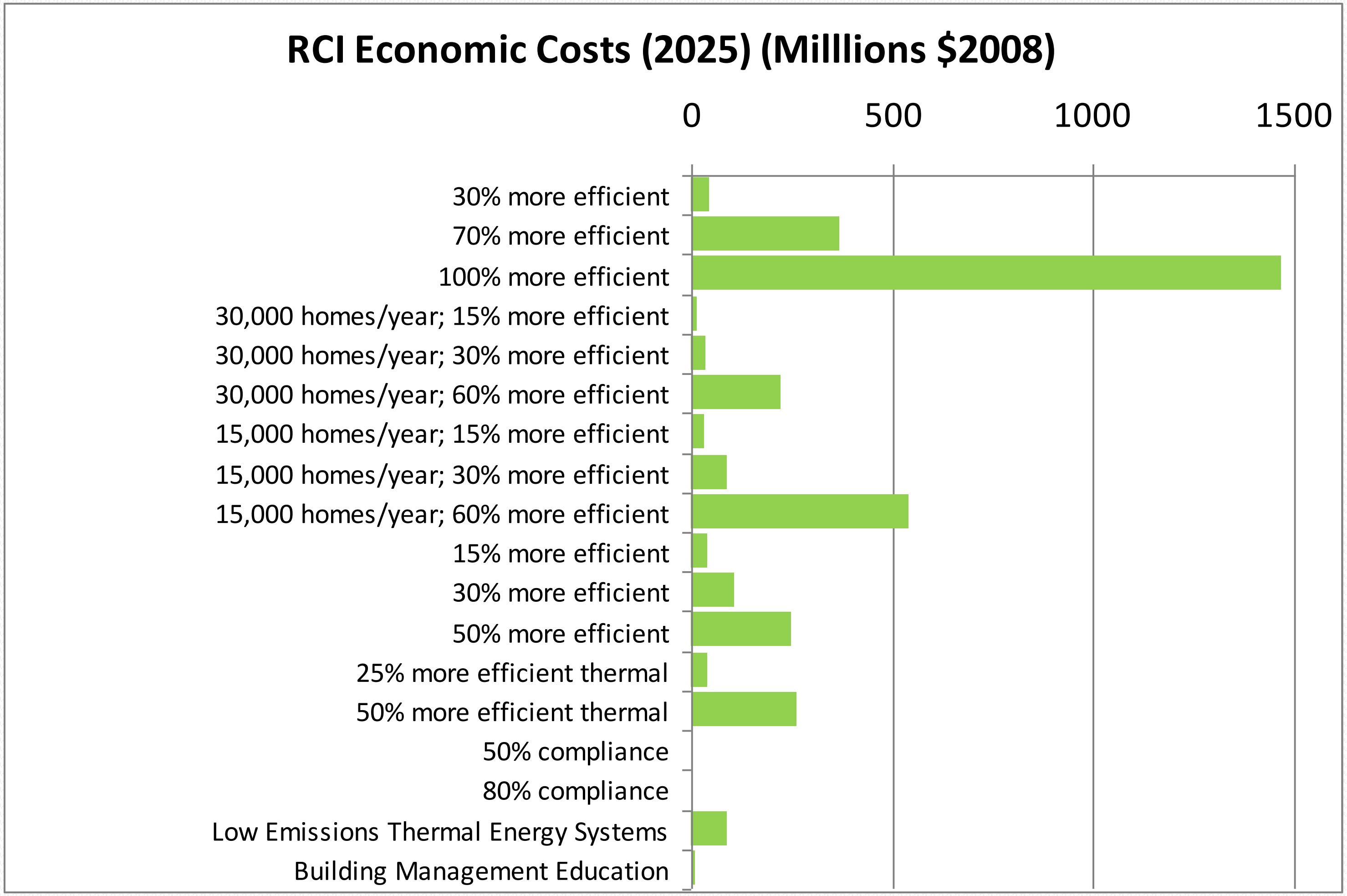
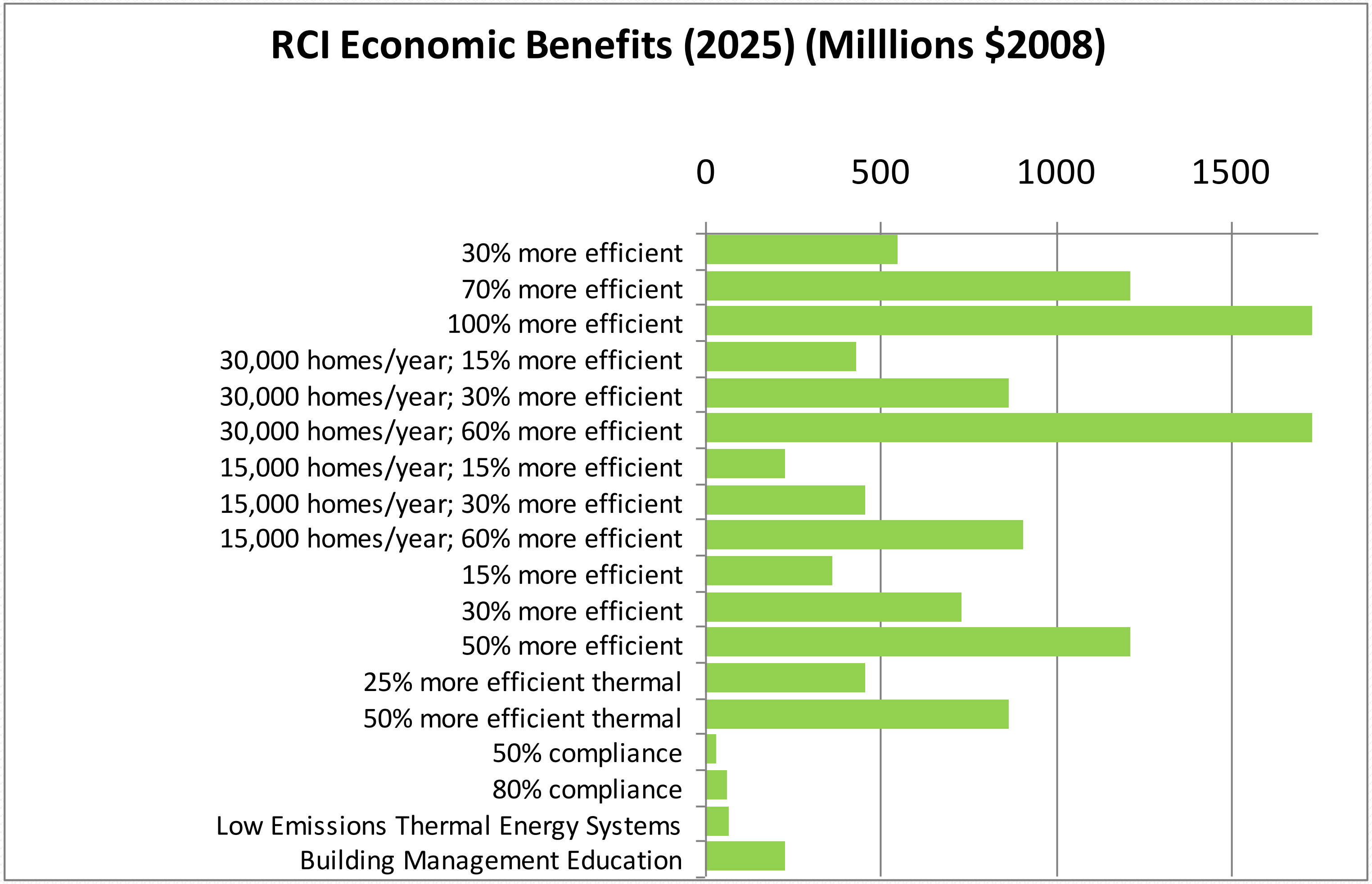
Overview of RCI Policies

- The majority of actions proposed had significant economic benefits expected as a result of their implementation
- Most significant proposed action in terms of total economic benefits was Action 1.1 Maximize Efficiency in New Construction (100%) ~$1.7 billion in economic benefits annually in NH by 2025
- Examples of policies that appear to meet economic "criteria"
  - Action 1.1 – Maximize Efficiency in New Construction – 25%
  - Action 1.3 Maximize Efficiency in Existing Commercial & Industrial – 15%
  - Action 1.4B - Increase Building Energy Code Compliance -50%

RCI Annual Implementation Costs



RCI Annual Economic Benefits



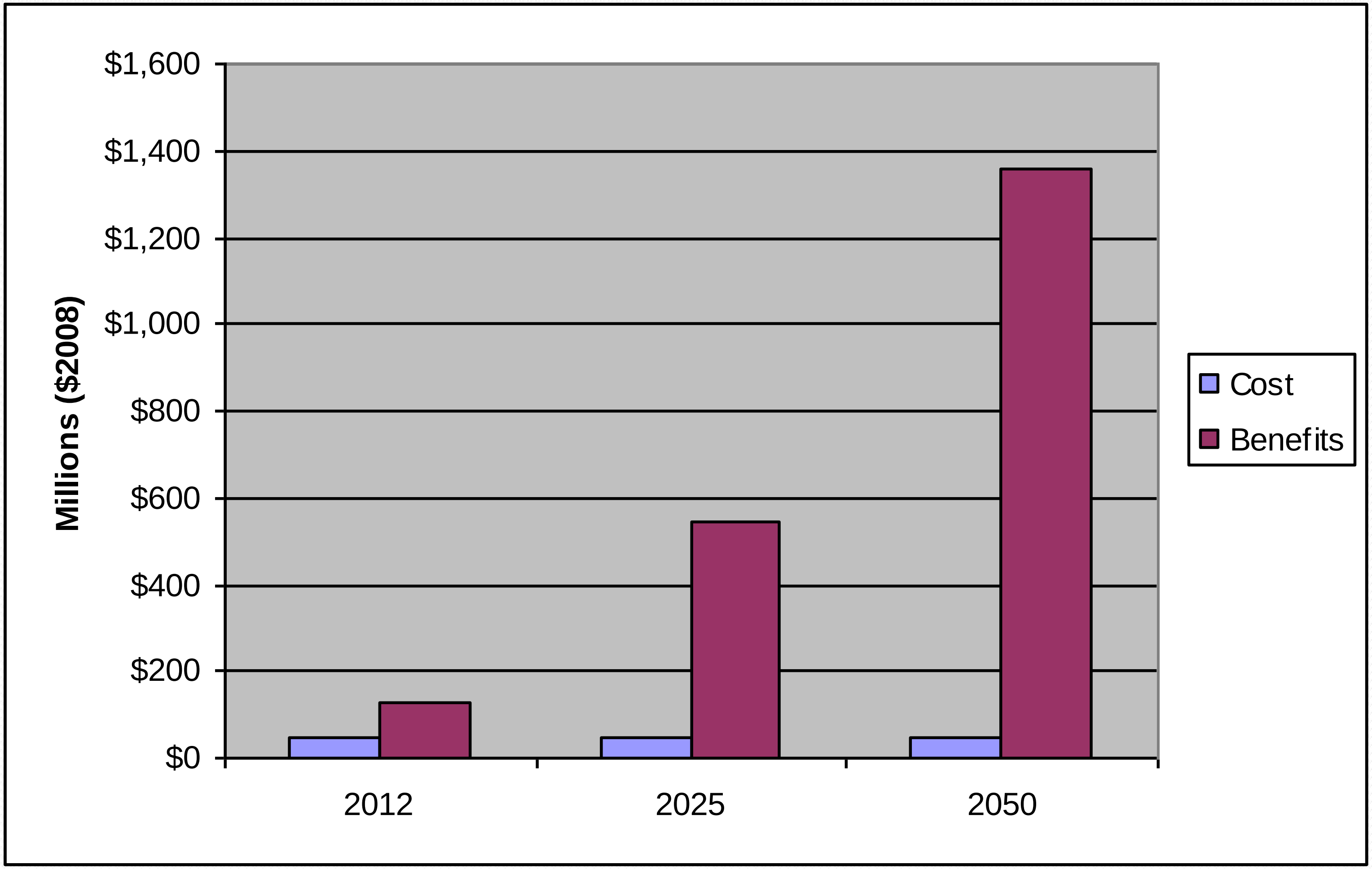
Illustrative Example:

Action 1.1 Maximize Efficiency in New Construction- 30%

- Cost Calculation
  - Added unit cost – (RCI Working group assumption)
    - $3000 per residence
    - $2 per SQ FT –Commercial
    - $4 per SQ FT –Industrial
  - New residences and buildings from CSNE carbon model
  - Total annual cost of $45 million in 2025
- Benefits Calculation
  - Savings based on fuel savings from CSNE carbon model
  - $1 multiplier based on fuel savings
  - Total annual economic benefits of $545 million in 2025

Illustrative Example:

Action 1.1 Maximize Efficiency in New Construction- 30%



Illustrative Example:

Action 1.1 Maximize Efficiency in New Construction- 30%

- Costs
  - Implementation Cost– Moderate "$25 -$125 million" Timing of Costs – Constant/Even
  - Impacted – Evenly Distributed
- Economic benefits
  - Potential benefits– High "$0.5 - $1 billion"
  - Timing of Benefits– Low short-term/Mostly long-term
  - Impacted – Evenly Distributed

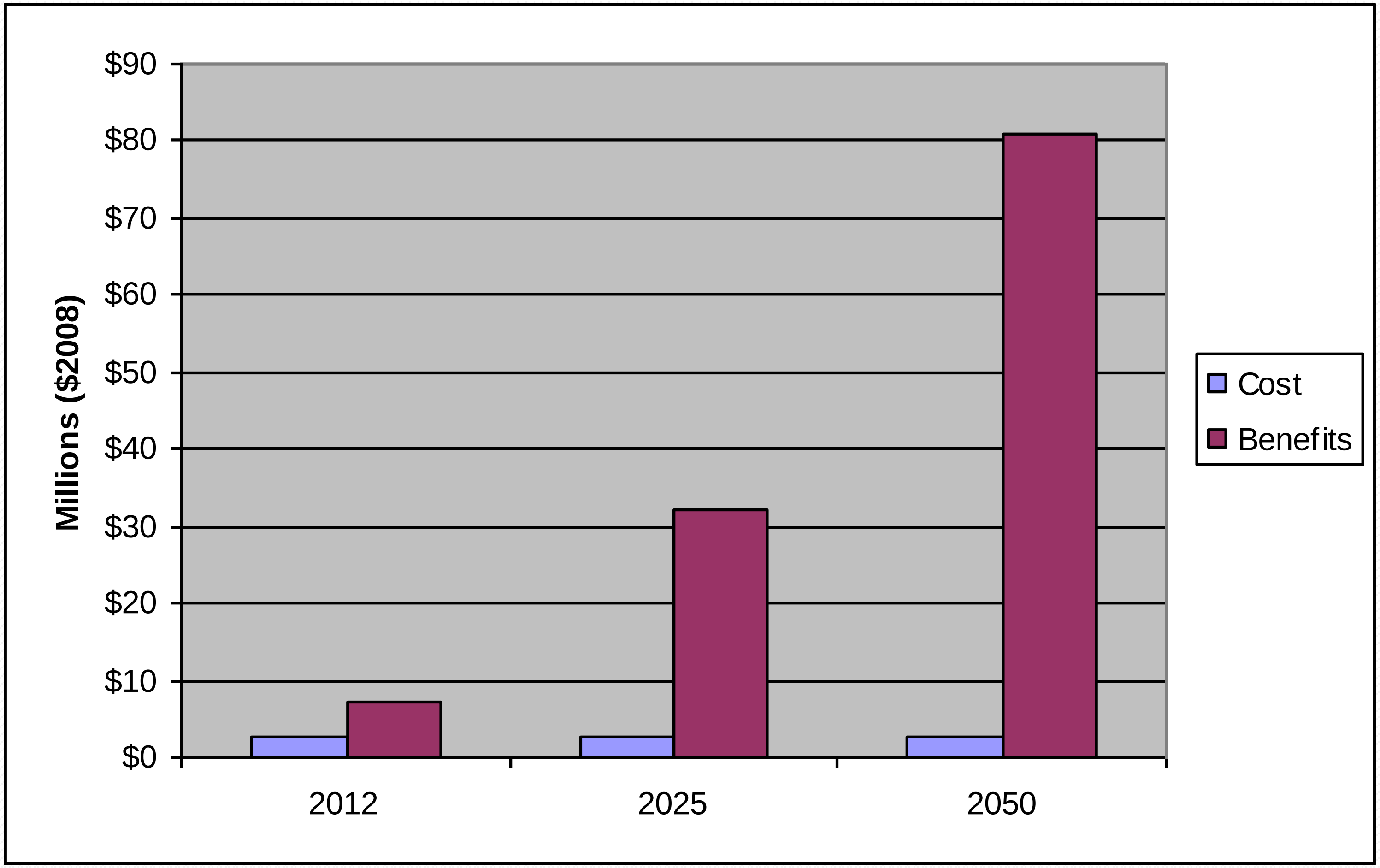
Illustrative Example:

Action 1.4B Increase Building Code Compliance

- Cost Calculation
  - Utilized population and sampling of different size towns to develop and estimate of 260 building inspectors statewide (UNH Economic team)
  - $1000 annual training (UNH Economic team)
  - Total annual cost of $260,000 million in 2025
- Benefits Calculation
  - Savings based on fuel savings from CSNE carbon model
  - $1 multiplier based on fuel savings
  - Total annual economic benefits of $32 million in 2025 (50% compliance)

Illustrative Example:

Action 1.4B Increase Building Code Compliance



Illustrative Example:

Action 1.4B Increase Building Code Compliance

- Costs
  - Implementation Cost– Low “$0 -$2.5 million”
  - Timing of Costs – Constant/Even
  - Impacted – Government – Local/State
- Economic benefits
  - Potential benefits– Moderately Low “$2.5 - $25 million”
  - Timing of Benefits– Low short-term/Mostly long-term
  - Impacted – Evenly Distributed

Illustrative Example:

Action 1.5 Establish an Energy Properties Section in MLS Listings

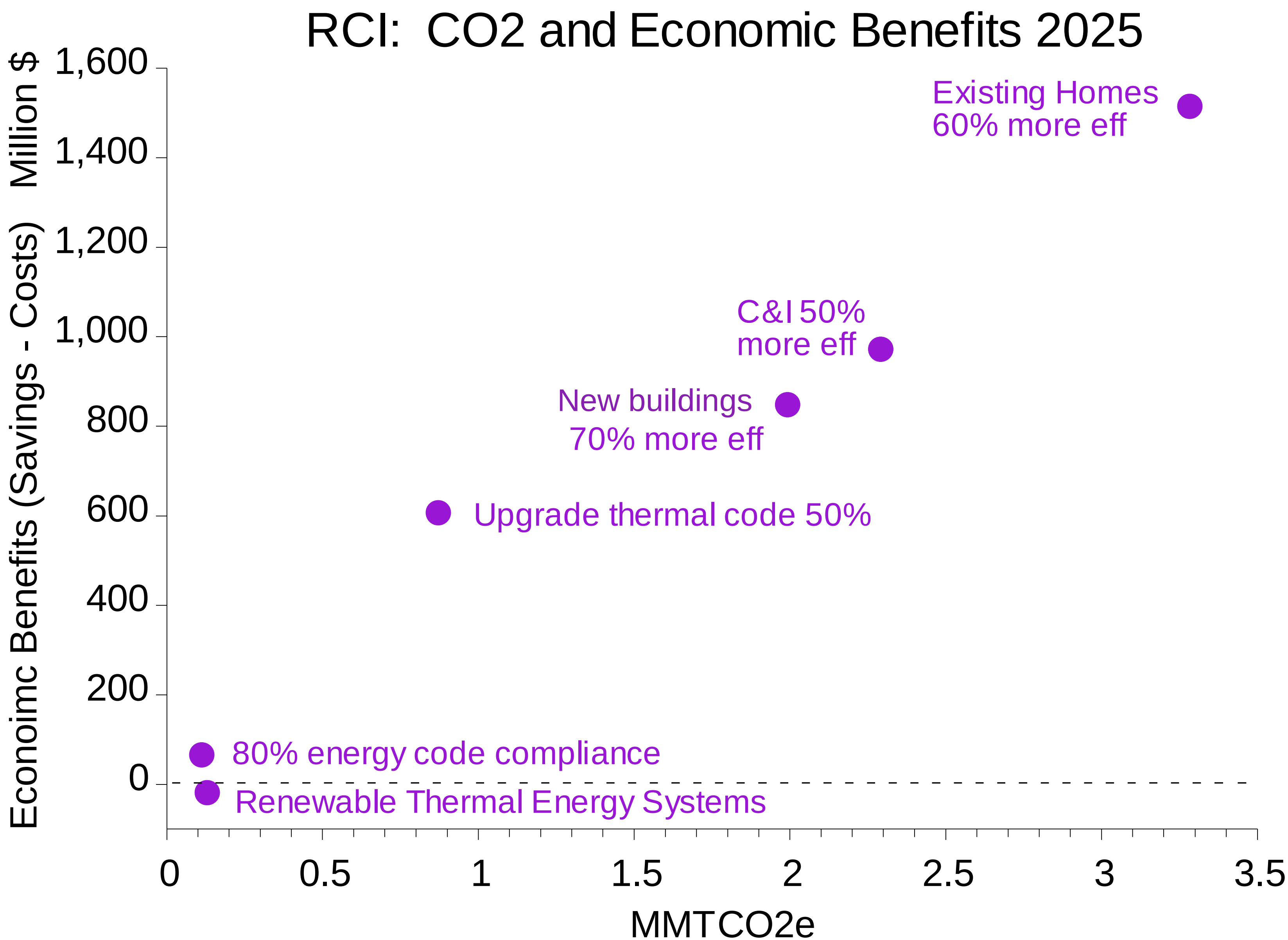
- Cost Calculation
  - Added cost per residence –
    - $20 per listing for incremental cost (Listed Green)
    - $200 for energy audit (A+ Energy)
  - Annual listings of used residence- ~20,000 (Realtor.org)
  - New homes estimated to be 6,200 per year (CSNE carbon model)
  - Recurring annual cost of ~ $6 million

- Benefits Calculation
  - Not estimated

Illustrative Example:

Action 1.5 Establish an Energy Properties Section in MLS Listings

- Costs
  - Implementation Cost– Moderately Low "$2.5 -$25 million"
  - Timing of Costs – Constant/Even
  - Impacted – Consumer
- Economic benefits
  - Supporting mechanism for action 1.1 and 1.2 (Residential)


RCI: CO2 and Economic Benefits 2025
Econoimc Benefits (Savings - Costs) Million $
1,600
1,400
1,200
1,000
800
600
400
200
0
Existing Homes
60% more eff
C&I 50%
more eff
New buildings
70% more eff
Upgrade thermal code 50%
80% energy code compliance
Renewable Thermal Energy Systems
0
0.5
1
1.5
2
2.5
3
3.5
MMTCO2e

New Hampshire Climate Change Policy Task Force
Fourth Task Force Meeting

9:50 AM	Overview of CSNE Results and Potential for Renewables
10:20 AM	Economic Perspective
10:50 AM	BREAK
11:00 AM	Emissions and Economic Impact of Working Group Actions
	Electric Generation and Use (EGU)
	Residential, Commercial and Industrial (RCI)
1:00 PM	BREAK FOR LUNCH
1:30 PM	Emissions and Economic Impact of Working Group Actions (cont'd)
	Transportation and Land Use (TLU)
	Agriculture Forestry and Waste (AFW)
3:15 PM	Task Force Next Steps

Transportation and Land Use: Emissions Model

Light Duty fleet:
- Cars / trucks (GVWR < 8,500 lbs)
- Sales rate / retirement rate
- Vehicle age
- Vehicle miles travelled
- Fuel efficiency
- Fuel carbon intensity
• **BAU**: continue sales trends, apply most recent VMT/vehicle and fuel efficiency

Heavy Duty fleet:
- Single unit / combination trucks (GVWR > 8,500 lbs)
- Miles travelled
- Fuel efficiency
- **BAU**: ~2.2% growth projection of VMT, apply most recent fuel efficiency

Transportation and Land Use: Example Calculation

CAFE Standards and VMT Reductions:

- CAFE: 35, 40, 45, 50 MPG   VMT: 0.5, 1, 5, 10, 20, 30, 40, 50% reduction

	Year	2008	2009	2010	2020	2030	2040	2050
sales growth rate								
1.20%	**Cars and Small SUV Sales**	47,117	47,682	48,254	54,368	61,256	69,016	77,760
1.20%	**Trucks and SUV Sales**	47,117	47,682	48,254	54,368	61,256	69,016	77,760
	Number of Cars and Small SUVs	659,159	661,157	663,409	723,341	817,091	920,610	1,037,244
	Number Trucks and SUVs	581,872	590,073	597,537	648,260	724,164	815,909	919,278
	Car and Small SUV MPG New Car Fuel Efficiency	27.5	27.5	27.5	27.5	27.5	27.5	27.5
	Truck and SUV MPG New Car Fuel Efficiency	22.7	23.4	23.7	23.7	23.7	23.7	23.7
annual VMT %reduction	**Car and Small SUV VMT/vehicle**							
2.8%	new	17,119	17,119	17,119	17,119	17,119	17,119	17,119
annual VMT %reduction	**Truck and SUV VMT/vehicle**							
2.8%	new	13,117	13,117	13,117	13,117	13,117	13,117	13,117
	Car and Small SUV Total VMT							
	TOTAL CAR VMT (million miles)	8,451	8,591	8,728	10,224	11,602	13,072	14,728
	AVERAGE VMT / CAR (miles)	12,820	12,994	13,157	14,134	14,199	14,199	14,199
	Truck and SUV Total VMT							
	TOTAL TRUCK VMT (million miles)	7,049	7,066	7,076	7,193	8,011	9,026	10,170
	AVERAGE VMT / TRUCK (miles)	12,114	11,976	11,841	11,096	11,062	11,062	11,062

Emissions factors [lb CO2/gallon]	
Gasoline	19.564
Diesel	22.384

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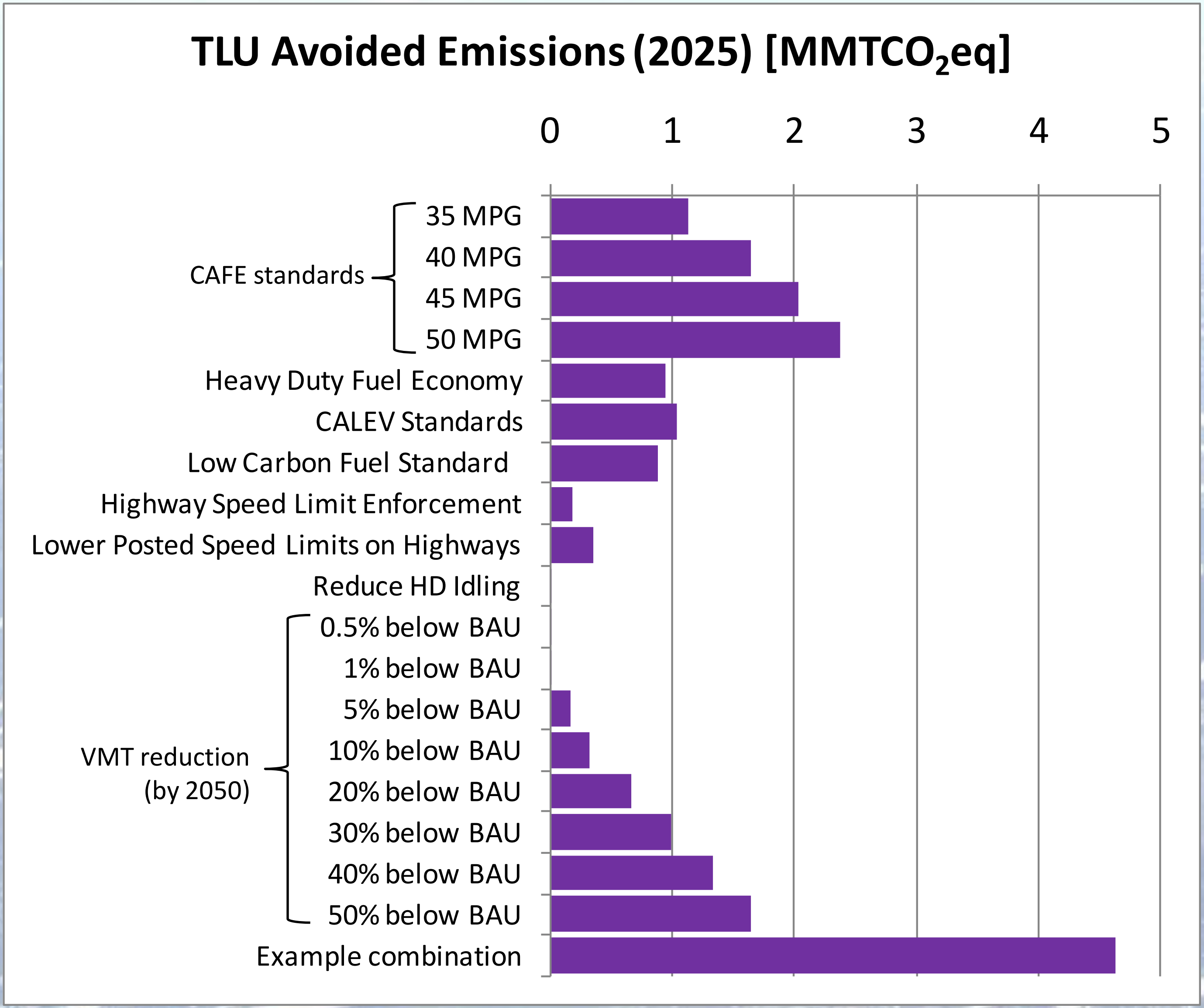
Transportation and Land Use: Avoided Emissions



BAU Transportation Emissions (2025) = 12.66

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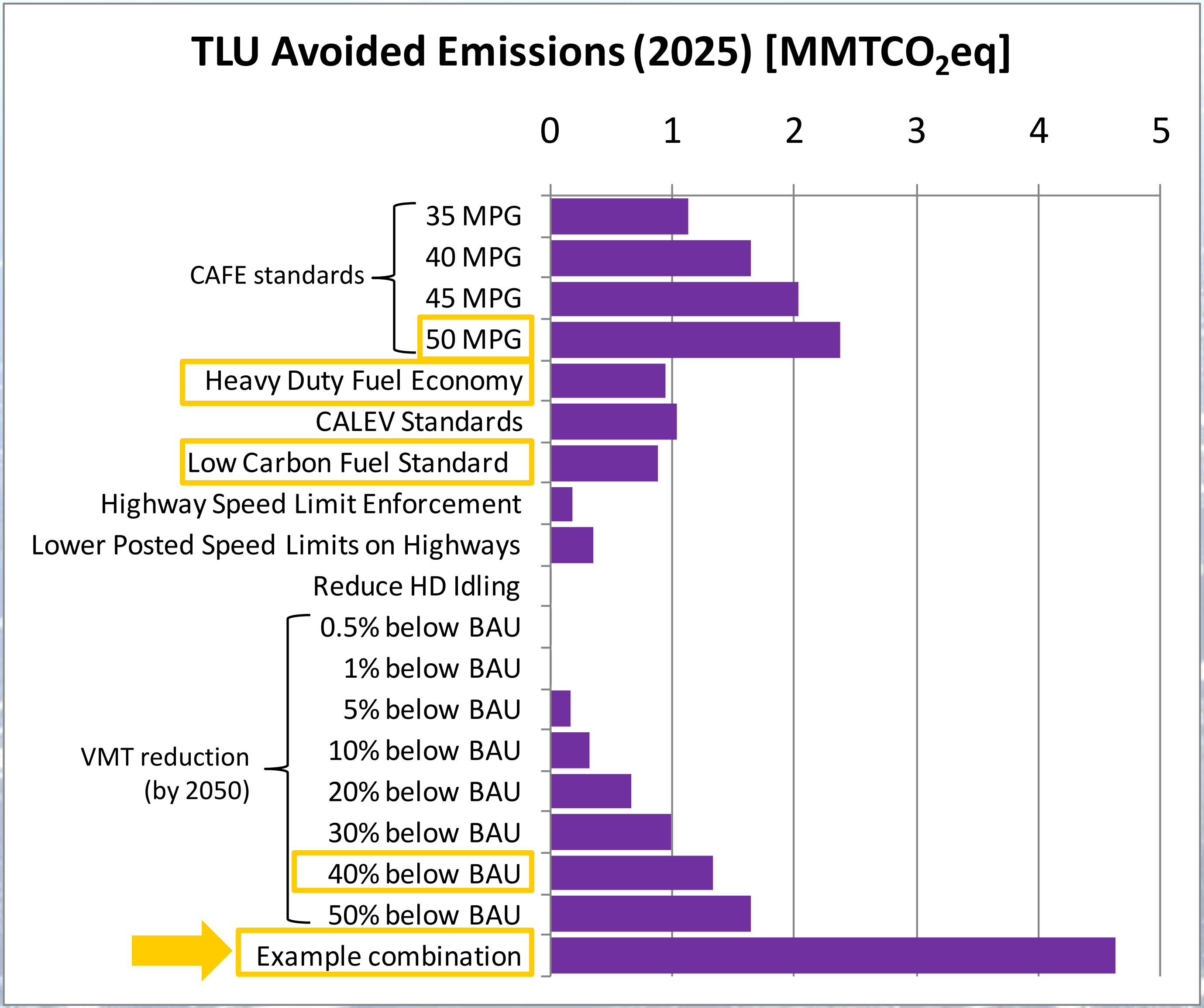
Transportation and Land Use: Avoided Emissions



BAU Transportation Emissions (2025) = 12.66

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Overview of TLU Policies

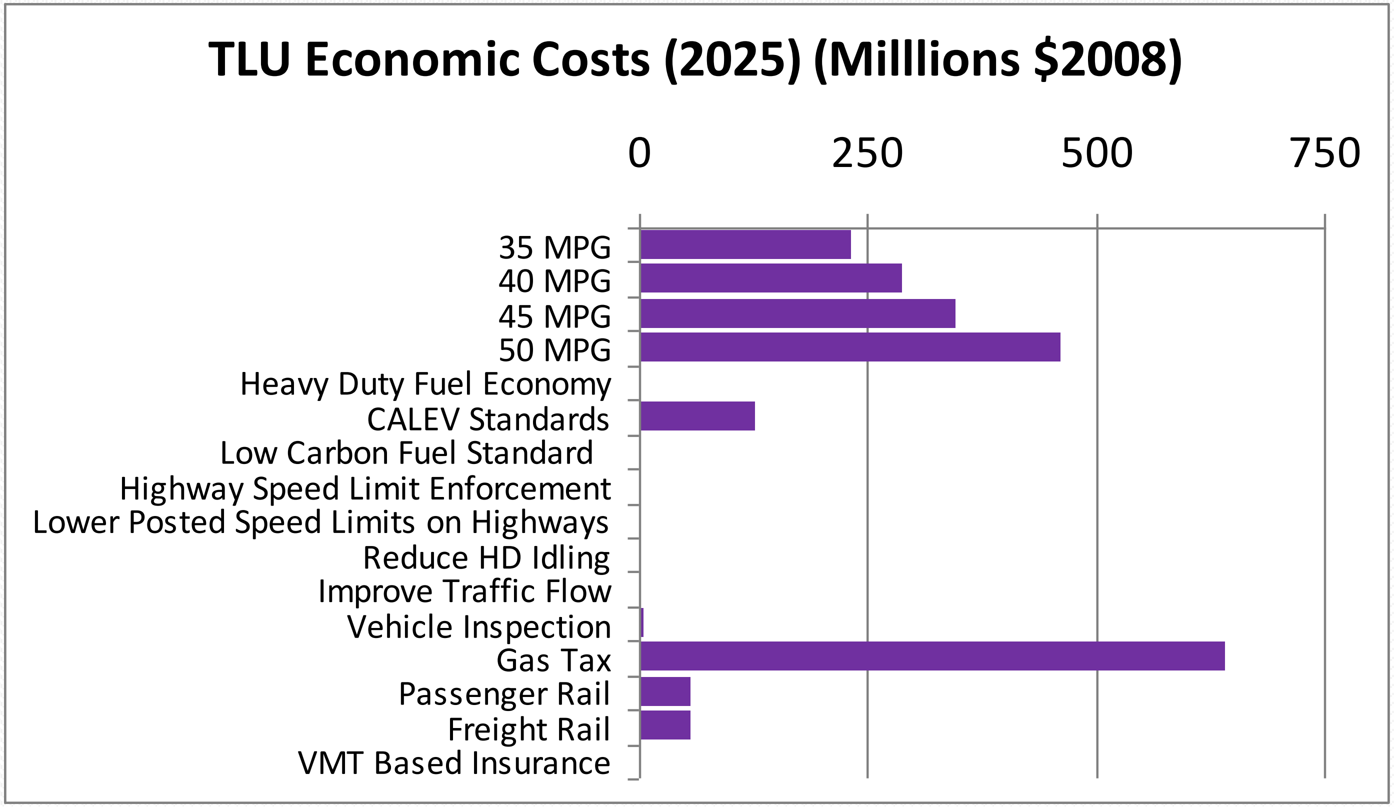
- A significant number of actions proposed had significant economic benefits expected as a result of their implementation

- Most significant proposed action in terms of total economic benefits was Goal 2 Reduce Vehicle Miles Travelled by 50% ~$1.7 billion in economic benefits annually in NH by 2025

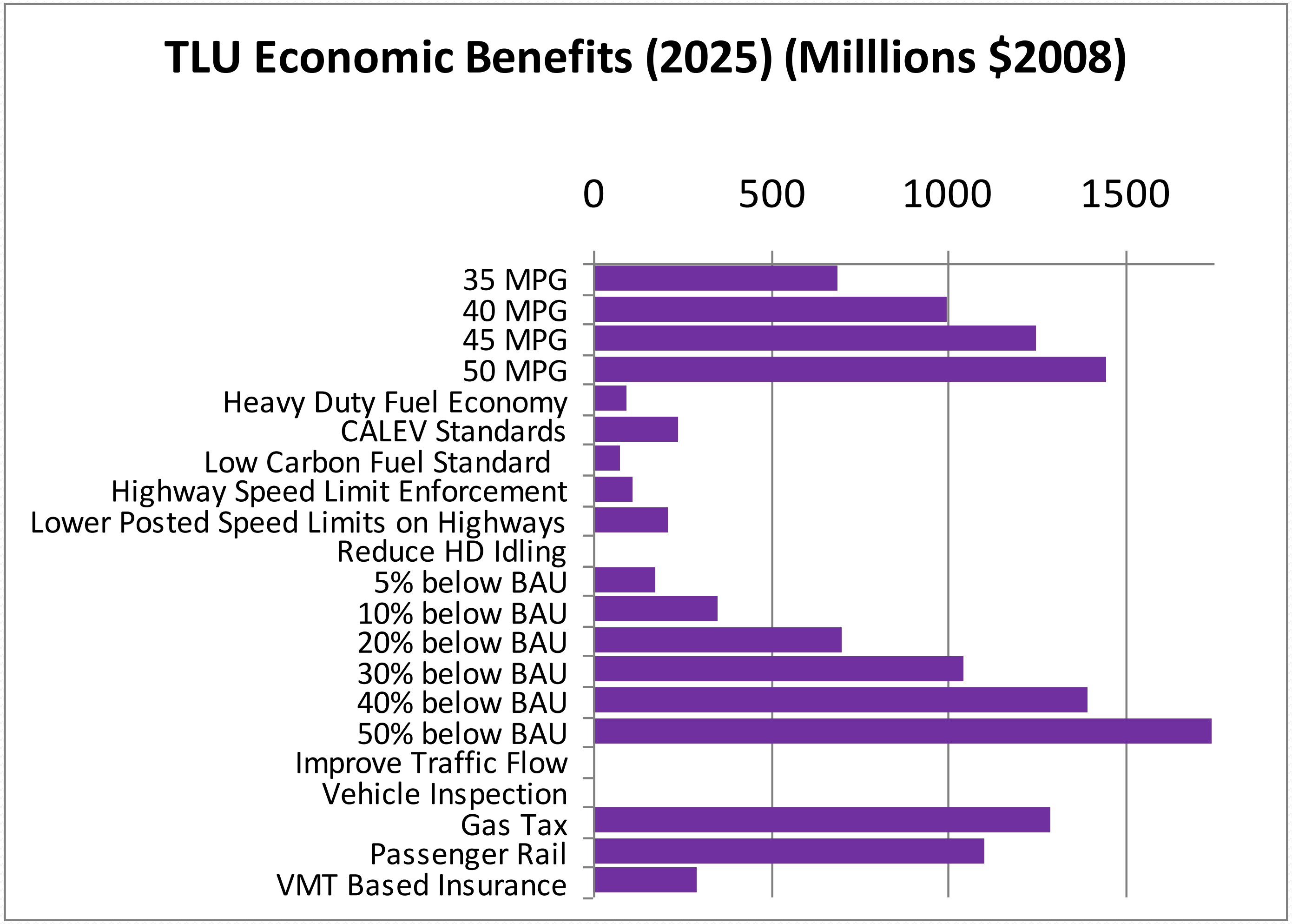
- Examples of policies that appear to meet economic "criteria"
  - Action 1.C.1. - Low Carbon Fuel Standard
  - Action 1.D.1. Speed limits
  - Actions 2.B.2.a and 2.B.2.b - Establishing a Statewide Rail System (Passenger and Freight)

TLU Annual Implementation Costs

- Chart does not show all actions (displays most significant in terms of cost)



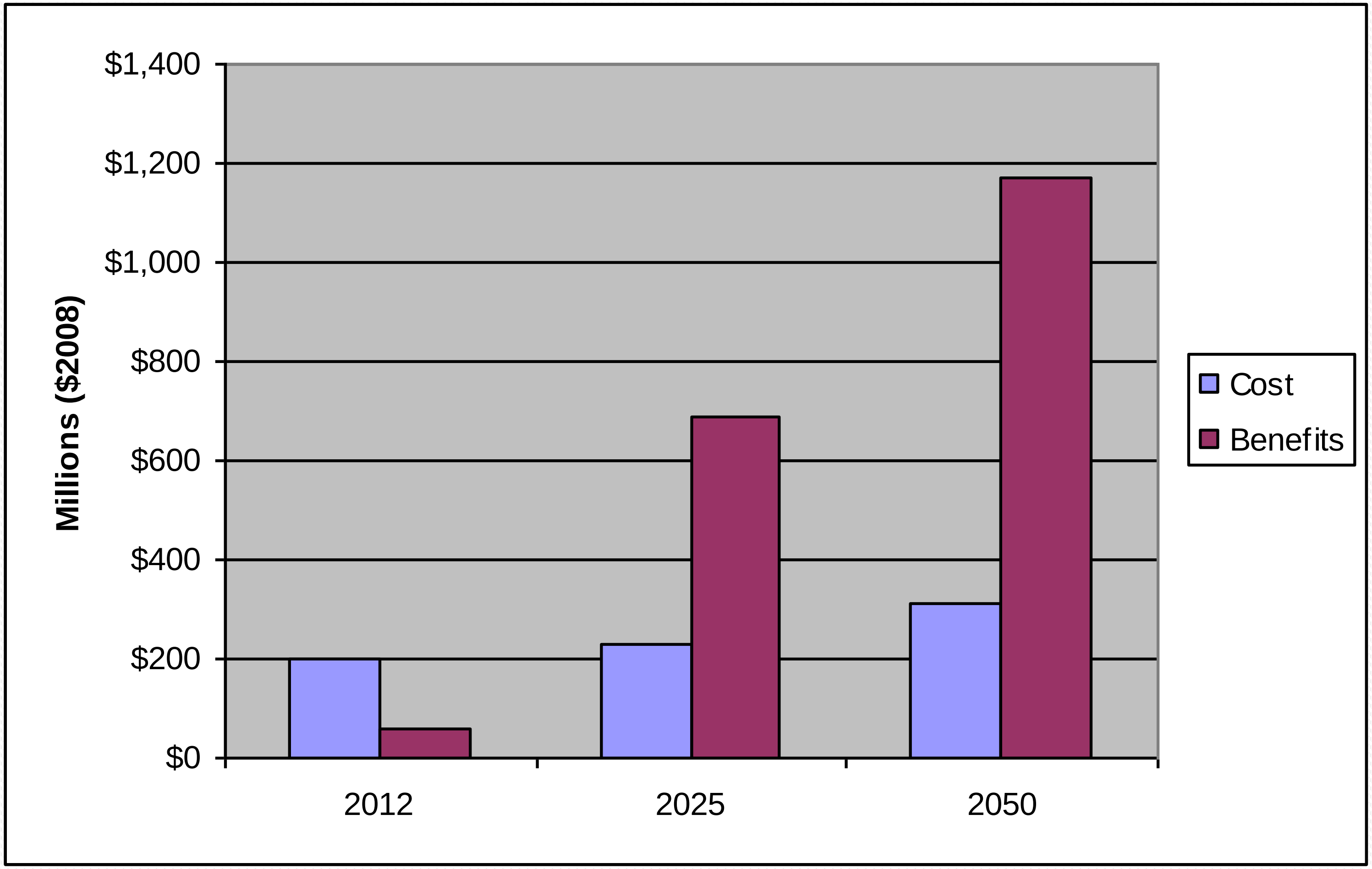
TLU Annual Economic Benefits



Illustrative Example:
Action 1.A.1 CAFE Standard (35 MPG)

- Cost Calculation
  - Added vehicle cost - $2000 per vehicle (TLU Working group assumption)
  - New cars from CSNE carbon model
  - Total annual cost of $230 million in 2025
- Benefits Calculation
  - Savings based on fuel savings from CSNE carbon model
  - $1 multiplier based on electricity savings
  - Total annual economic benefits of $689 million in 2025

Illustrative Example:
Action 1.A.1 CAFE Standard (35 MPG)



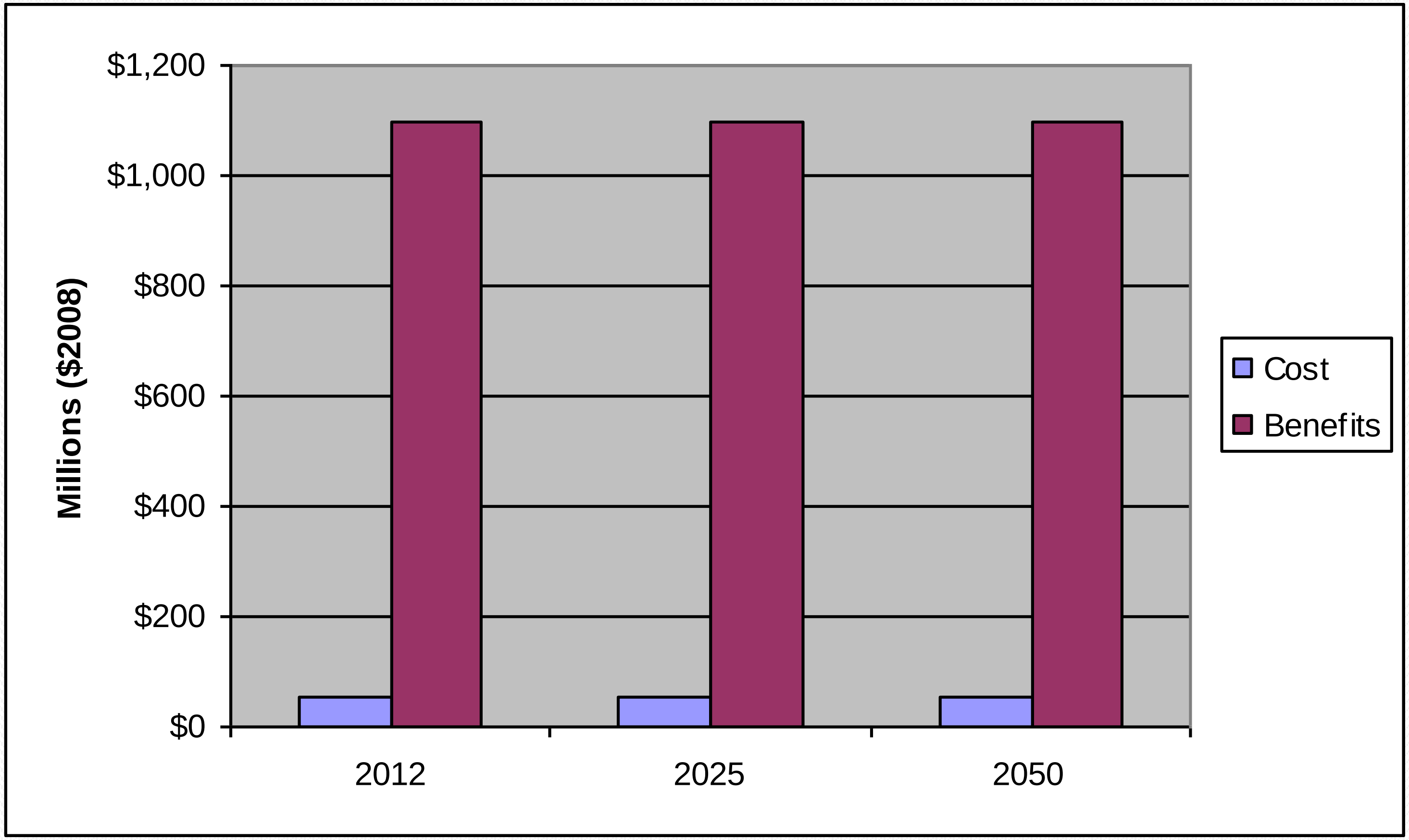
Illustrative Example:
Action 1.A.1 CAFE Standard (35 MPG)

- Costs
  - Implementation Cost– Moderately High “$125-$150 million”
  - Timing of Costs – Constant/Even
  - Impacted – Consumer
- Economic benefits
  - Potential benefits– High “$0.5 - $1 billion”
  - Timing of Benefits– Low short-term/Mostly long-term
  - Impacted – Consumer

Illustrative Example:
Action 2.B.2.a CAFE Passenger Rail

- Cost Calculation
  - $50 million ($2005) annually (TLU Working group)
  - Total annual cost of $55 million in 2025
- Benefits Calculation
  - Based on populations of Strafford, Rockingham and Hillsborough counties
  - Utilized Amtrak Downeaster study released in March 2008
  - Economic benefits include construction, fuel savings and visitor spending
  - Total annual economic benefits of $1.1 billion in 2025

Illustrative Example:
Action 2.B.2.a CAFE Passenger Rail



Illustrative Example:

Action 2.B.2.a CAFE Passenger Rail

- Costs
  - Implementation Cost– Moderate "$25-$125 million"
  - Timing of Costs – Constant/Even
  - Impacted – Evenly Distributed
- Economic benefits
  - Potential benefits– Very High "Greater than $1 billion"
  - Timing of Benefits– Constant/Even
  - Impacted – Evenly Distributed

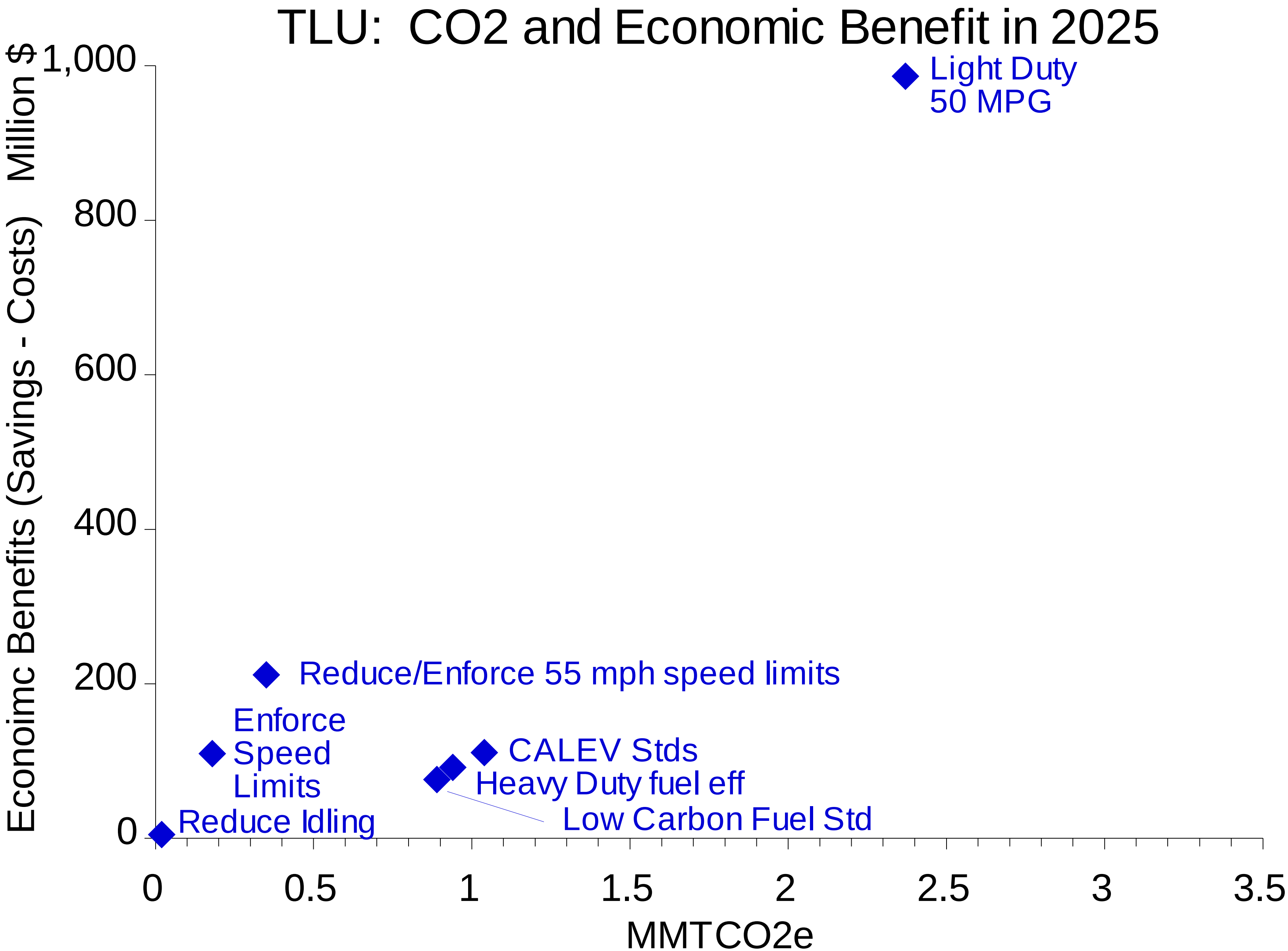
Illustrative Example:
Action 2.C.1.a GHG Development Impact Fees

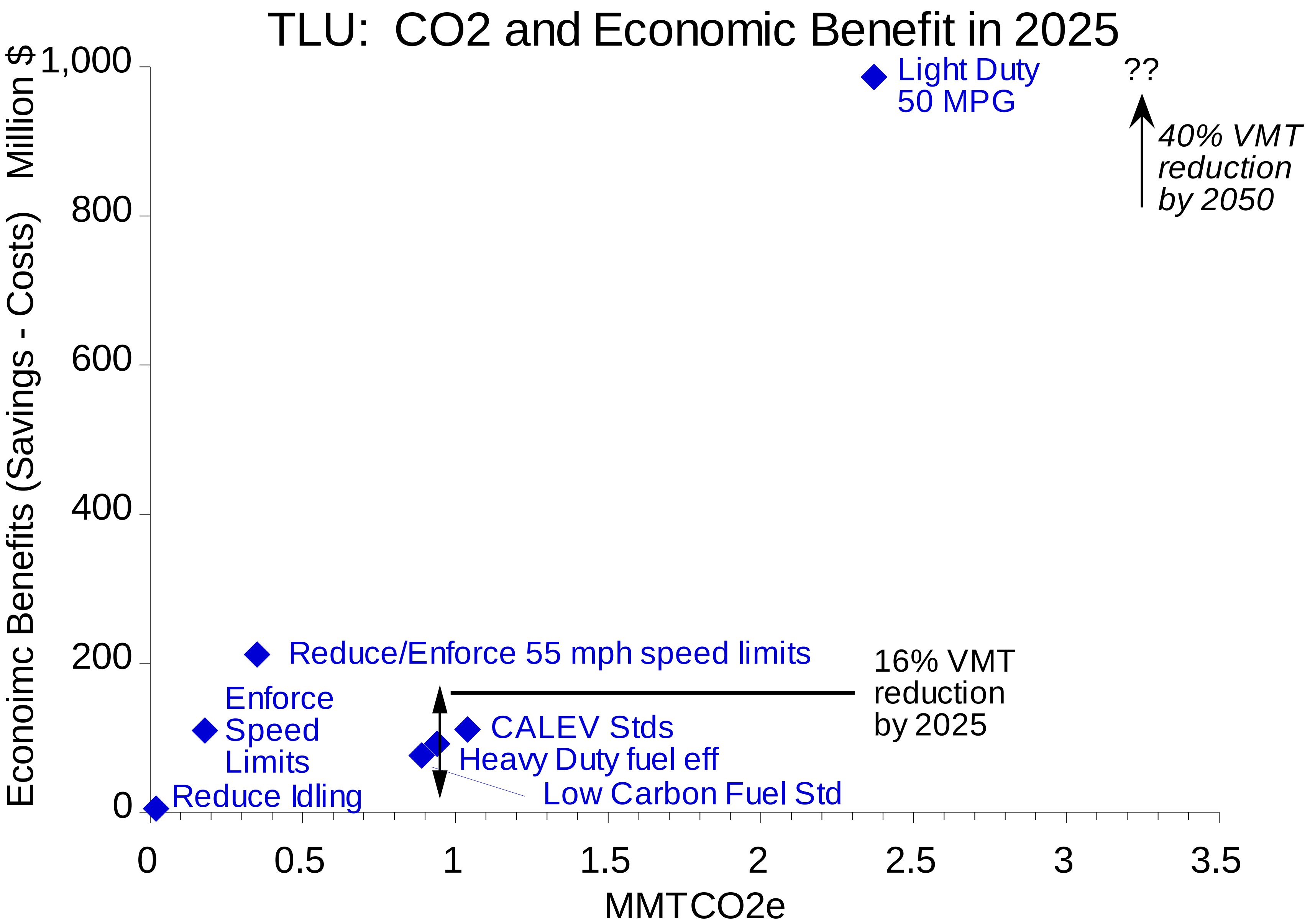
- Cost Calculation
  - Administrative costs of $50,000 (TLU Working group assumption)
  - Permit revenue offset by benefits of streamlined permitting (2.C.1.b)
  - Total annual cost of $50,000 in 2025
- Benefits Calculation
  - Not Calculated

Illustrative Example:

Action 2.C.1.a GHG Development Impact Fees

- Costs
  - Implementation Cost– Low “$0-$2.5 million”
  - Timing of Costs – Constant/Even
  - Impacted – Government - State
- Economic benefits
  - Supporting mechanism for VMT reduction


TLU: CO2 and Economic Benefit in 2025
Econoimc Benefits (Savings - Costs) Million $
1,000
800
600
400
200
0
Light Duty
50 MPG
Reduce/Enforce 55 mph speed limits
Enforce
Speed
Limits
CALEV Stds
Heavy Duty fuel eff
Low Carbon Fuel Std
Reduce Idling
0
0.5
1
1.5
2
2.5
3
3.5
MMTCO2e


TLU: CO2 and Economic Benefit in 2025
Econoimc Benefits (Savings - Costs) Million $
1,000
800
600
400
200
0
0
0.5
1
1.5
2
2.5
3
3.5
MMTCO2e
Light Duty 50 MPG
??
40% VMT reduction by 2050
Reduce/Enforce 55 mph speed limits
16% VMT reduction by 2025
Enforce Speed Limits
CALEV Stds
Heavy Duty fuel eff
Low Carbon Fuel Std
Reduce Idling

Agriculture, Forestry, and Waste: Model and Actions

Agriculture:
- Agricultural land area and soil carbon content

Forest land conversion:
- Determine the woody biomass + forest floor + soil carbon
- All carbon emitted except durable wood products

Durable wood products:
- Product percentage of harvest
- Durable percentage of products

Woody biomass harvest:
- Determine the amount (by mass and energy) of sustainable woody biomass that can be sustainably harvested
- Apply energy to electric load or thermal load

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Agriculture, Forestry, and Waste: Example Calculation

Wood for Energy:

- Determine energy content of sustainable harvest

			Biomass	Electricity Generation	Percent of Total NH Generation	CO2 Offset
			BBTUs	(MWh)		(MMTCO2e)
Increment + Removals			**55449**	4,370,267	20.2%	1.74
	Less Removals		28845			
Unharvested			**26604**	2,096,820	9.7%	0.84
	Less Restricted	50%	13302			
Available Unharvested			**13302**	1,048,410	4.9%	0.42

Current Average Heat Rate
(12,687 BTU/kWh)

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Agriculture, Forestry, and Waste: Example Calculation

Avoid forested land conversion:

Storage	
Standing Woody Biomass [million english tons]	163
Standing Woody Biomass [MMT]	179.7
NH forest area [million acres]	4.82
Woody Biomass [MT/acre]	37.28
"an average amount for forest floor/upper soil biomass" [english tons/acre]	25
"an average amount for forest floor/upper soil biomass" [MT/acre]	27.6
Total forest biomass [MT/acre]	64.84
Percent of forest carbon that is woody (non-soil) biomass	57.5%
Carbon % of woody biomass	50%
Forest carbon (standing woody biomass + floor and upper soil) [MT C/acre]	32.42
Forest carbon (standing woody biomass + floor and upper soil) [MTCO2eq/acre]	**118.78**
Total statewide forest carbon storage [MMT C]	156.25
Total statewide forest carbon storage [MMTCO2eq]	**572.52**
Conversion	
NH forest conversion rate [acres/year]	17,500
% of woody biomass that would *not* be converted into durable products	65.1%
% of total carbon that would *not* be converted into durable products	79.9%
Annual CO2e loss [MMTCO2e/year]	1.66

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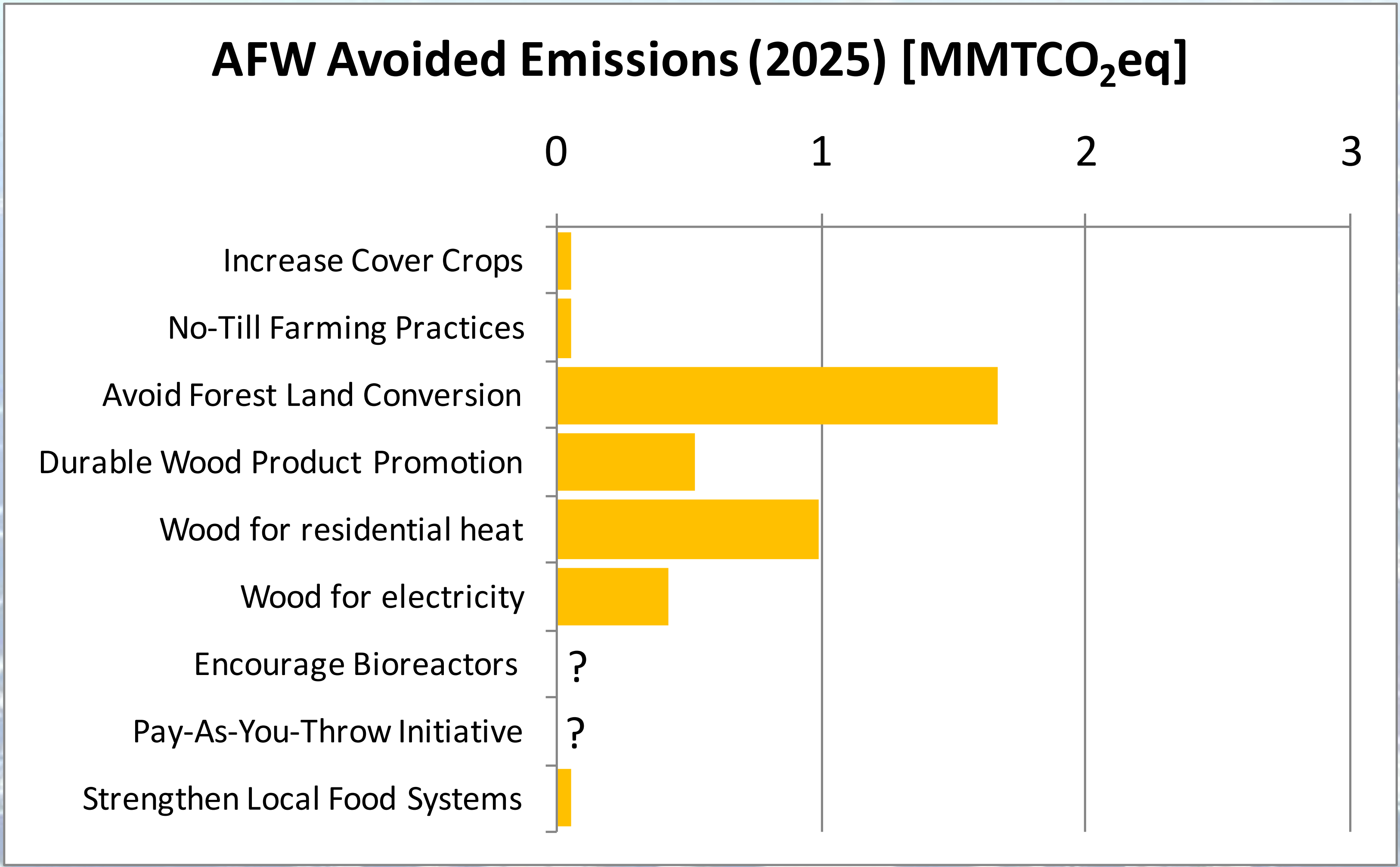
Agriculture, Forestry, and Waste: Avoided Emissions

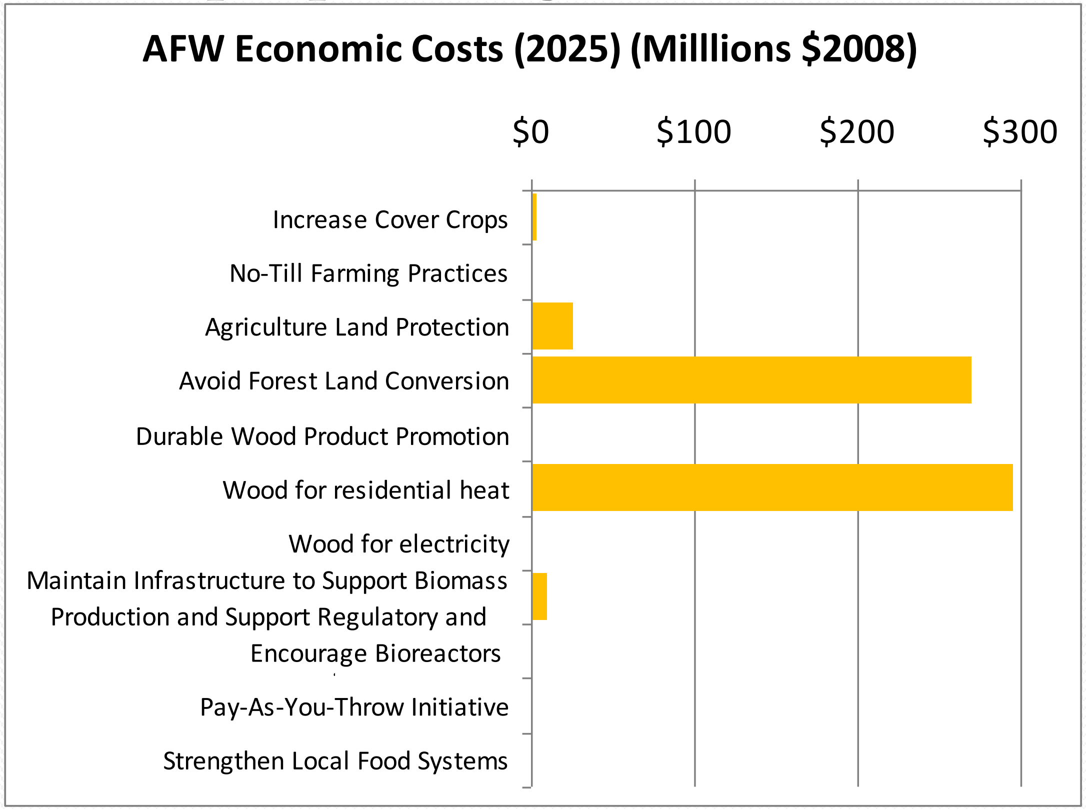


Overview of AFW Policies

- Of the different working group proposed actions, AFW had the lowest amount of economic impact. Forestry related initiatives appear to be most significant.
- Most significant proposed action in terms of total economic benefits was Action 1.2.1 Avoiding Forest Land Conversion - ~$120 million in direct economic benefits annually in NH by 2025
- Information about sustainable wood harvest from CSNE Carbon analysis suggest that residential heating with wood may have significant economic benefits that may warrant further consideration as an action item
- Examples of policies that appear to meet economic "criteria"
  - Action 1.3 – Durable Wood Product Promotion
  - Action 3.1 – Pay-As-You-Throw Initiative
  - Action 2.2.1 - Maintain Infrastructure to Support Biomass Production and Support Regulatory and Business Efficiencies

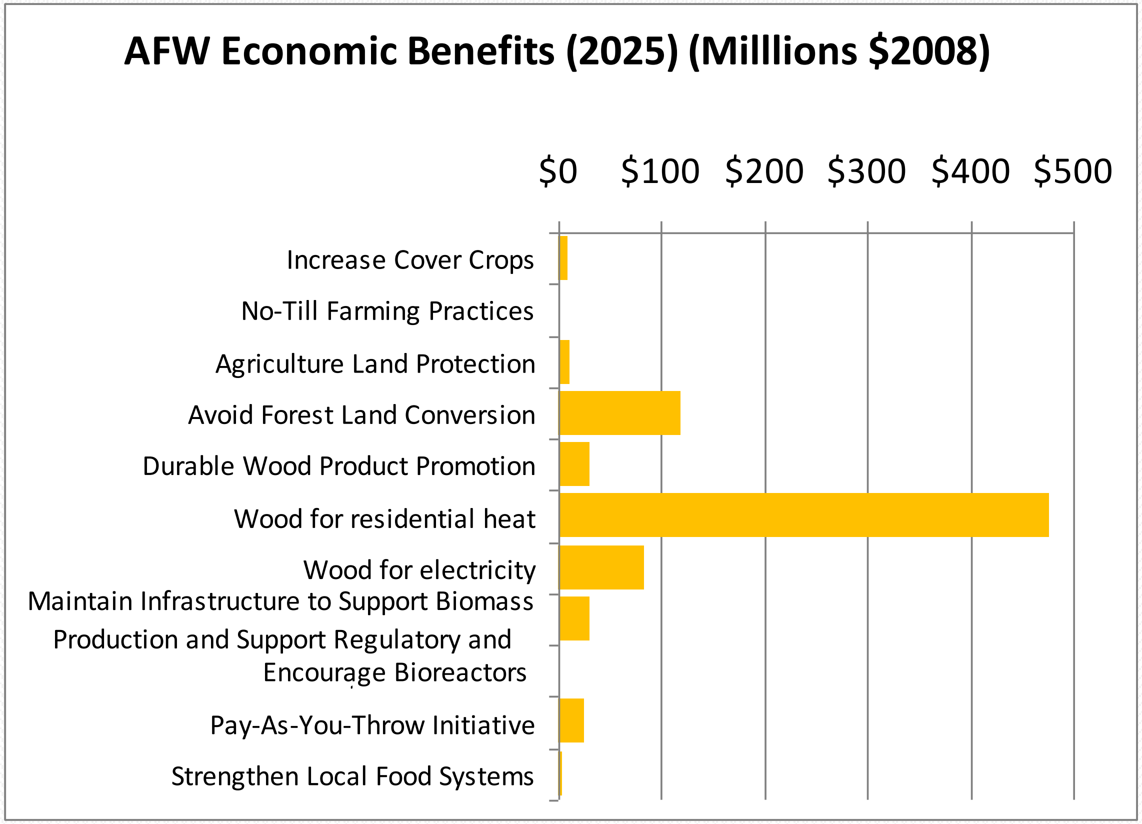
AFW Annual Implementation Costs

- Most actions have relatively low cost compared to other actions proposed by the other working groups



AFW Annual Economic Benefits

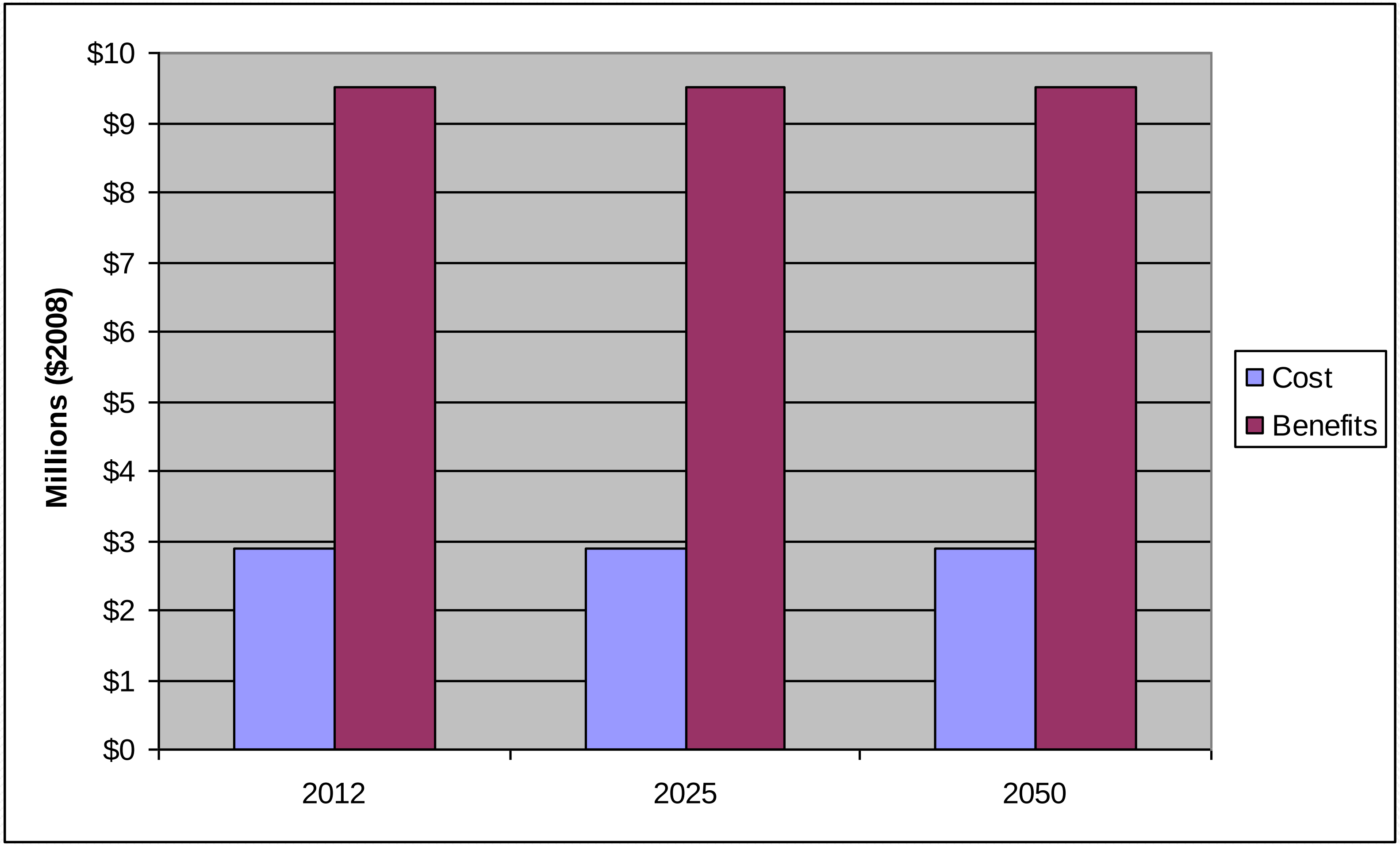
- Most actions have relatively low benefits compared to other actions proposed by the other working groups



Illustrative Example: Action 1.1.1 Increase Cover Crops

- Cost Calculation
  - 100% of actively used farmland for crop planting – 100,000 acres (USDA Economic Research Service)
  - Cost to plant an acre - $28 (MD Dept. of Agriculture)
  - $100,000 for government to administer annually
  - Total annual cost of $2.9 million
- Benefits Calculation
  - Economic value of cover crop - $95 per acre (National Sustainable Agriculture Information Service)
  - Total annual economic benefits - $9.5 million

Illustrative Example: (Continued) Action 1.1.1 Increase Cover Crops



Illustrative Example: (Continued) Action 1.1.1 Increase Cover Crops

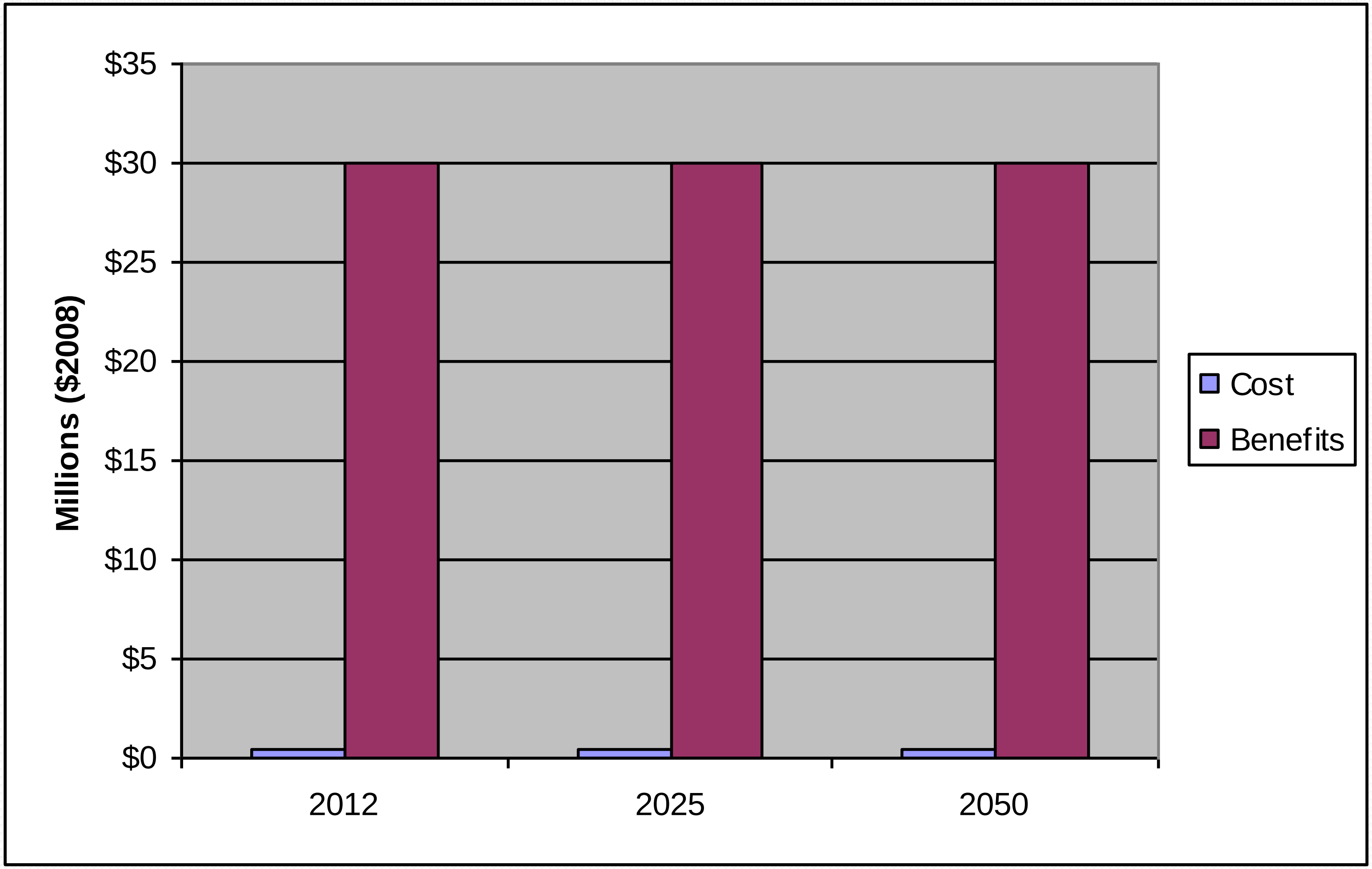
- Costs
  - Implementation Cost– Moderately Low "$2.5 -$25 million"
  - Timing of Costs – Constant/Even
  - Impacted – Business – Small (Farms)
- Economic benefits
  - Potential benefits– Moderately Low "2.5 - $25 million"
  - Timing of Benefits – Constant/Even
  - Impacted – Business – Small (Farms)

Illustrative Example:
Action 1.3 Durable Wood Product Promotion

- Cost Calculation
  - $500,000 for marketing promotion (UNH Economic team)
  - Total annual cost of $0.5 million
- Benefits Calculation
  - 2% increase in economic output in forest economy (UNH Economic team)
  - $1.5 billion industry (NH Timberland Owner's Association)
  - Total annual economic benefits - $30 million

Illustrative Example: (Continued)

Action 1.3 Durable Wood Product Promotion



Illustrative Example: (Continued)

Action 1.3 Durable Wood Product Promotion

- Costs
  - Implementation Cost– Low “$0-$2.5 million”
  - Timing of Costs – Constant/Even
  - Impacted – Government - State
- Economic benefits
  - Potential benefits– Moderately “25 - $125 million”
  - Timing of Benefits– Constant/Even
  - Impacted – Business

Illustrative Example:

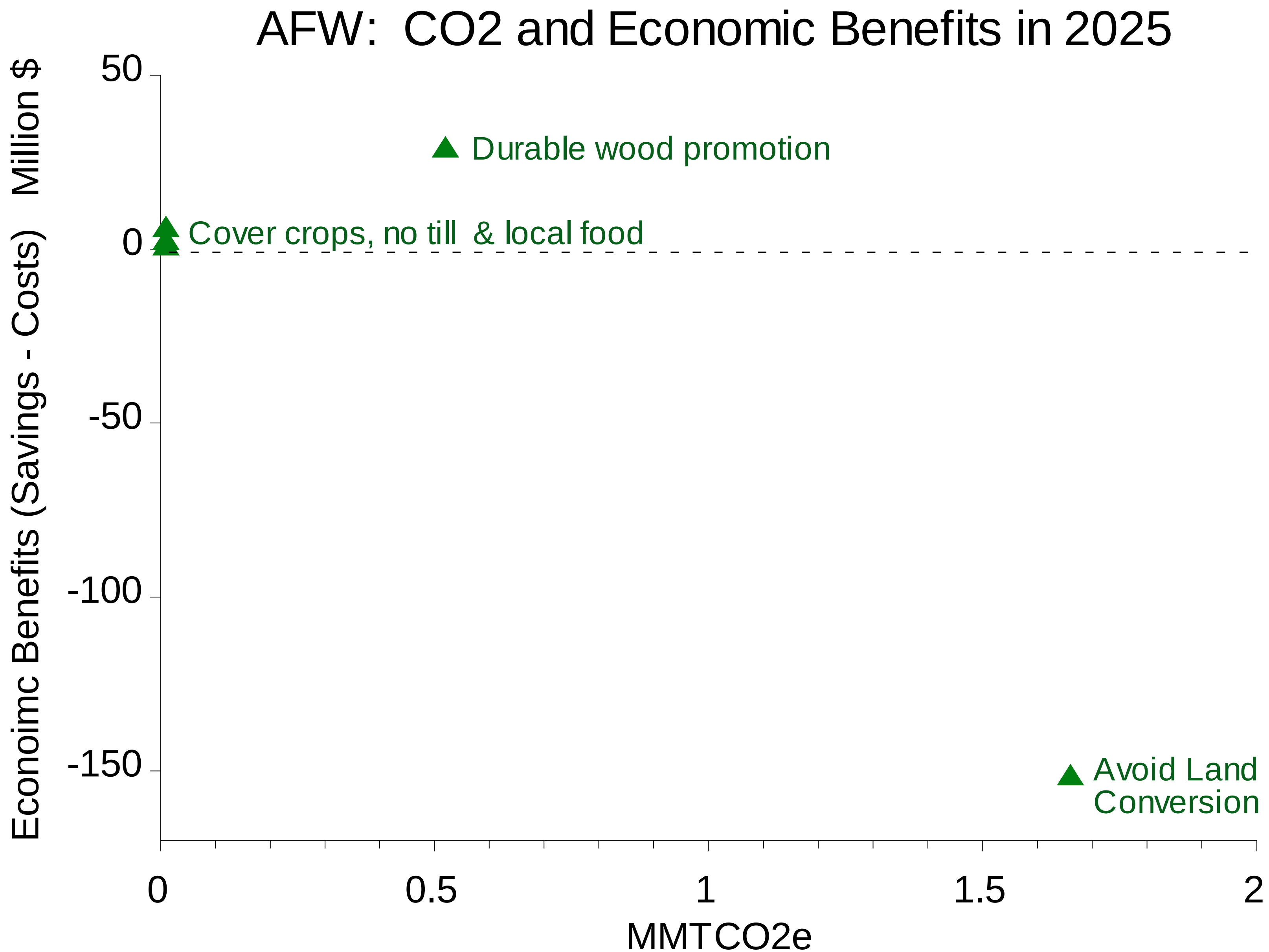
Action 2.2.2 Ensure Biomass Consumption is Sustainable

- Cost Calculation
  - $100,000 to study the issue and $100,000 for administration (UNH Economic team)
- Benefits Calculation
  - Not calculated

Illustrative Example:

Action 2.2.2 Ensure Biomass Consumption is Sustainable

- Costs
  - Implementation Cost– Low "$0-$2.5 million"
  - Timing of Costs – Constant/Even
  - Impacted – Government - State
- Economic benefits
  - Supporting mechanism for renewable power generation in the region


AFW: CO2 and Economic Benefits in 2025
Econoimc Benefits (Savings - Costs) Million $
50
0
-50
-100
-150
Durable wood promotion
Cover crops, no till & local food
Avoid Land Conversion
0
0.5
1
1.5
2
MMTCO2e

New Hampshire Climate Change Policy Task Force
Fourth Task Force Meeting

9:50 AM	Overview of CSNE Results and Potential for Renewables
10:20 AM	Economic Perspective
10:50 AM	BREAK
11:00 AM	Emissions and Economic Impact of Working Group Actions
	Electric Generation and Use (EGU)
	Residential, Commercial and Industrial (RCI)
1:00 PM	BREAK FOR LUNCH
1:30 PM	Emissions and Economic Impact of Working Group Actions (cont'd)
	Transportation and Land Use (TLU)
	Agriculture Forestry and Waste (AFW)
3:15 PM	Task Force Next Steps

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